NUCLEAR ENGINEERING VOL. 5 NO. 55 DECEMBER, 1960

The Case For A U.K. Forum

GRADUALLY the idea is gaining ground in the United Kingdom that even if Commonwealth considerations in agriculture prevent our integration with the inner six it is to the advantage of the nuclear industry that closer collaboration be organized with commercial undertakings in the Community. If this collaboration can be fostered within the framework of a greater Europe so much the better, but it is the activities of the inner six with which one is most concerned. On a Government level the United Kingdom has been taking down the barriers and encouraging closer association, if not integration, through the medium of direct exchange agreements and joint participation in OEEC projects. There is the bilateral agreement with Euratom for information exchange and both are concerned with the ENEA projects, Halden and Dragon.

At the industrial level although many companies have close ties with concerns abroad there is no formal liaison with the European nuclear industrial associations. To assess the general feelings in this country the FBI has decided to call together relevant bodies to determine whether there is a general wish that the U.K. should formally associate itself with the new European organization FORATOM.

The Continental Associations

Before however examining this proposal in detail it is as well to have clear the structure and functions of the organizations operating on the Continent. On pages 540-541 the president of FORATOM describes the motivating forces and the specific objectives of FORATOM. It is seen that the organization regards itself almost entirely as a public relations body, whose primary function (to continue Professor Matteini's metaphor) is to purge atomic energy's original sin of having been born a bomb. FORATOM then is in no sense an industrial federation and its membership is not restricted to commercial organizations. The seven organizations which make up its present membership (the inner six plus Switzerland) are not identical in functions, the French and German associations in the shape of ATEN and the Deutsches Atomforum, having a somewhat greater technical and scientific interest than the others, but it cannot be too strongly emphasized that the trade interest is negligible.

The reason for this absence of direct commercial concern is that there already exists an organization within the Community whose primary function is the promotion and co-ordination of commercial interests. For three years the Union des Industries de la Communauté Européenne (UNICE) has been guarding the interests of industry in the inner six and its special commission on atomic energy affairs, the Commission Euratom de l'UNICE has been the main industrial contact for the politically inspired Euratom. The Commission is the co-ordinating body for the national atomic energy federations or special groups within the national industrial federations. France and Belgium have set up special nuclear energy federations, the Groupe Intersyndical de l'Industries Nucléaire in France and the Groupement Professionnel de l'Industrie Nucléaire in Belgium, whereas in Germany the representative body is the Arbeitskreis für Atomfragen, a section of the Bundesverband der Deutschen Industrie, and in Italy the Comitate dell'Energia Nucleare, a section of the Confererazione Generale dell'Industria Italiana. Luxembourg is directly represented by the Fédération des Industriels Luxembourgeois and the Netherlands by the Industrial side of Reactor Centrum Nederland, the Commissie Bedrijfsleven under the auspices of Den Haag.

If Euratom wishes to discuss the industrial implications of one of its policies, for example patents or a particular course of development, it is to the Commission Euratom de l'UNICE that it will go, and this Commission will draw upon the specialists within its member organizations for expert comment. In the special case of patents the French group BREVATOM will also be involved. It is not easy to draw a completely sharp line of distinction between the rôles of FORATOM and UNICE, nor to find terms which describe adequately their different operation spheres but, for the purposes of this discussion, the interests of FORATOM will be described as "public relations" and those of UNICE "commercial."

In the United States the U.S. Atomic Industrial Forum

is designed to combine the two functions but it has yet to succeed completely in eliminating overlapping with other bodies as is demonstrated by the holding of two Atom Fairs this year, one under the auspices of the Forum in association with the American Nuclear Society—designed to fulfil the functions of a "learned nuclear society"—and the other under the auspices of the Engineers Joint Council. There are clear indications that the struggles for influence are being resolved and industry is placing its weight in future behind the Forum where, at least to an outsider, it should obviously be.

The U.K. Organizations

Turning to the U.K., the picture is greatly confused and it is high time that some order and reason were brought into the structure of the organizations that have grown up, and the various committees rationalized into effective bodies which can genuinely speak for the members that they purport to represent. Nominally the organization which represents the commercial interests of industry is NETAC, the Nuclear Energy Trade Association Conference—a confusion of terms which is perhaps symptomatic of the confusion of functions. Its constituent members are the British Chemical Plant Manufacturers' Association, the British Electrical and Allied Manufacturers' Association, the British Engineers' Association, the British Measuring and Control Apparatus Manufacturers' Association, the Scientific Instrument Manufacturers' Association, the Society of British Aircraft Constructors, Ltd., and the Water-Tube Boilermakers' Association. Its activities have been largely confined to the organization of exhibitions and at Geneva in 1958 it was responsible for the mounting of the British section of the commercial exhibition there. More recently it has co-ordinated the British participation in the Fifth International Instruments and Measurements Exhibition in Stockholm and in this narrow field of activity its efforts have not gone unrewarded.

The prime reason for its formation, however, was a negative one rather than a positive, it being felt, in the early days of development, by the established associations and by the contracting consortia that it would not be in their interests for a special association to be formed. In the early days the larger manufacturers were opposed to general collaboration and were keen to bargain independently with the only national organization with whom they were concerned, viz. the Atomic Energy Authority. As a result it was easy for the Authority to drive wedges between the consortia and almost impossible for the smaller manufacturers to make themselves heard.

On the scientific side a somewhat similar reasoning led to the formation of the BNEC, the British Nuclear Energy Conference, originally comprising five major learned societies and now extended to nine. Its most important function was to minimize competition between the established institutions in the acquisition of papers by atomic energy notabilities and also to prevent the formation of a specialist nuclear energy institution. Apart from its organization of the Calder Hal Symposium in November, 1956, its positive contributions to nuclear energy development have been small. It has been only partially successful in preventing the formation of a specialist institution in view of the existence of the Institution of Nuclear Engineers, although this new body has yet to prove itself acceptable to the majority of established nuclear engineers.

The two central organizations therefore, NETAC and the BNEC are both stop-gap organizations with no clear mandate to promote or encourage developments, but rather charged with the responsibility of preventing effective co-ordinated specialist action. As a result there is no equivalent of FORATOM or of UNICE in the United Kingdom today and there is no organization able to speak with the authority or on the same subjects as FORATOM and UNICE.

The nearest equivalent to the overseas organizations is the FBI's Nuclear Energy Conference Committee. In this title the term conference is used advisedly as the FBI felt it necessary to provide in this country a means of reaching commercial interests at the same level as the Stresa conference and in 1958 held a successful business conference at Eastbourne on the lines of a miniature Stresa. Over the past year it has been trying to gauge industry's reactions to proposals for a nuclear engineering exhibition in this country and has been considering a follow-up to the Eastbourne exercise. It is the FBI who is taking this latest initiative in trying to determine industry's reactions to a union with FORATOM in the full knowledge that this will require a forum in the U.K. whose terms of reference are similar to those of FORATOM's constituents.

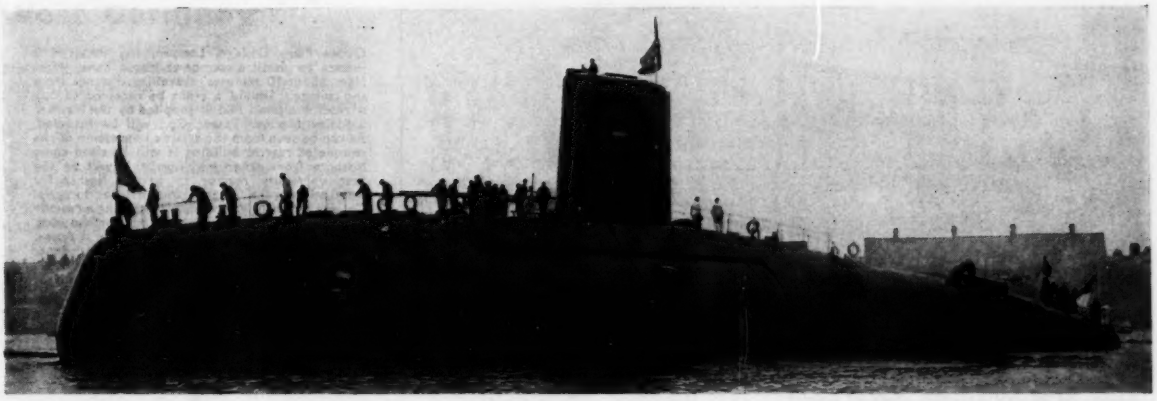
The Need for A Forum

But is this enough or is it indeed the most important? Although not all the problems are solved, the ghost of radiation danger is very largely laid in the United Kingdom and the problems of public relations are small. The controlled public reaction to Windscale gave ample proof of the public's general acceptance of atomic energy and its attendant risks; the CEGB, on many occasions, has stated that its own public relations problems are almost entirely concerned with amenities and it has few worries over radiation hazards. The incentive therefore, for a forum to be set up in this country to speak to the public is small, although we do believe that a forum should be established to act within FORATOM in order that the British viewpoint be not ignored at international gatherings.

But we believe that it is even more important that a special federation be formed able to liaise directly with the special UNICE atomic energy commission, and furthermore represent the commercial interests of industry at home, conferring with, and where necessary opposing, the Government organizations in the shape of the AEA and the nationalized electricity undertakings. At present these large entrenched monopolies are able to establish their own terms and no single company has yet shown itself willing or able to stand against them. By now the major groups have come to realize that their strength lies in unity and not in independent negotiations and the same is even more true of the smaller companies. One of the great strengths of the U.S. Forum is that it is able to discuss problems on a national basis, in the open and at the highest level.

We believe also, that in the long term, the AEA and the CEGB would welcome the formation of a federation and through it they would find it much easier to determine industry's aspirations and dissatisfactions and would at the same time gain a wider and more representative hearing for their own policies and viewpoints.

It is ironic that Britain, the most advanced nuclear country in Europe, should have such disorganized industrial representation. We hope that these first steps of the FBI can be quickly translated into comprehensive action and a representative forum established with two definite sections, the one charged with the responsibilities for public relations and a constituent of FORATOM, whilst the other actively and energetically promotes and represents commercial interests.



Britain's first nuclear submarine, H.M.S. *Dreadnought*, at Barrow-in-Furness, after her launching by H.M. The Queen. When completed she will have a slightly different appearance. Forward hydroplanes will have been fitted, the temporary protruding anchor hawser removed and the top deck made smooth. The depression midships is where the hull is to be pierced for the installation of the reactor and machinery.

World Digest

International

Patent arrangements more equitable to Euratom contractors are to be made. Firms undertaking work for Euratom may be given ownership rights of the patents involved, although Euratom would have the right to use patents and issue licences.

Some 140 scientists from 29 countries attended the symposium on pile neutron research in physics organized by the IAEA in Vienna. Another IAEA symposium, devoted to the inelastic scattering of neutrons in solids and liquids, was attended by 128 scientists from 24 countries. At both symposia observers from international organizations also participated.

For four days nautical experts have been discussing at Tarmina, Sicily, problems associated with nuclear ship propulsion. Some 40 papers were read at the symposium, organized by the IAEA, covering legal, economic and safety aspects of the subject.

WELCOME is the new information service provided by the IAEA in the form of a bulletin entitled "Some Recent Activities of IAEA." Intended for the specialized Press it provides a fairly comprehensive, unofficial record of the proceedings of IAEA conferences, research work, missions, new publications and other activities.

Research contracts recently awarded by the IAEA included the following: The ion exchange of uranium and thorium in non-aqueous and mixed media—to the Second Institute of Chemistry, Vienna University; Study of the stability of reactor systems by means of an analogy simulator—to the Technion-Israel Institute of Technology, Haifa; Chemically induced metabolic modifications of cells susceptible to modify the sensitivity of micro-organisms to ionizing radiations—to the Institut d'Education Physique, Liège; An investigation of the factors which influence the movement of Sr^{90} from soils to plants—Division of Plant Industry, CSIRO, Canberra; Red cell survival studies with radioisotopes in thalassaemia haemoglobin-E and thalassaemia haemoglobin-H diseases—to the University of Medical Sciences, Bangkok; Comparison between modifications induced by ionizing radiations when nucleic acids are respectively irradiated within intact or lyophilized cells, within isolated cell nuclei or in the pure state—to the Physiological and Chemical Institute, Johannes Gutenberg University, Mainz; The induction of genetic mutations by irradiation in plant species of economic importance—to the Istituto di Genetica Vegetale dell'Universita del S. Cuore, Piacenza, Italy; Use of radiation treatment methods to study rice genetics and improve rice varieties used in Southern Asia—to Taiwan Provincial College of Agriculture, Taichung; and Investigation into the decay system of Tl^{210}—to the First Physical Institute, Vienna University.

The first issue of "Nuclear Fusion," an international quarterly journal devoted to plasma physics and controlled thermonuclear research, contains articles by experts from India, Britain, France and America. It is published by the International Atomic Energy Agency and the editorial board consists of 17 specialists from 11 countries.

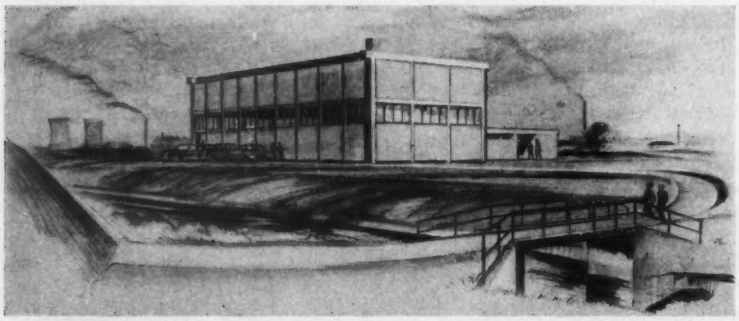
A sum of $3M is sought by Euratom for spending on nuclear ship propulsion during 1961 and a further $3M is sought for appropriation as regards this work later during the year. Euratom has available an R and D fund of $75M, plus $15M for power reactor assistance.

Broadcasting chiefs from seven European countries were recently shown over the proton-synchrotron buildings at CERN, Meyrin, Geneva. They were also shown a film of the organization's activities.

United Kingdom

To enable the CEGB to produce and sell radioisotopes a Bill to amend the Electricity Act, 1957, is to be read during the current parliamentary session. Under existing legislation the Board is precluded from manufacturing anything other than electricity or what is required for research and development, or for repair and maintenance. The Board's nuclear power stations, the first of which will come into operation next year, will provide substantial capacity for irradiating materials to produce radioisotopea and the purpose of the Bill is to enable the Board to make use of this facility. The Bill also provides for the raising by the board of extra capital necessary for implementing the provisions of the Bill. It is calculated that additional capital outlay needed will not be more than £¼M. The added capacity would greatly assist the present production from the AEA's reactors.

With H.M. the Queen to release the christening wine and it being Trafalgar Day when *H.M.S. Dreadnought* was launched, Britain's nuclear navy could not have had a better start. There were some stalwarts who were upset by the fact that the propulsion unit is to be of American design and construction, but there was the consolation that at least the hull was of British make. And, of course, it could always be remembered that the Navy's second nuclear submarine would be built entirely in the U.K.



Queen Mary College, London, has received a licence to install a reactor at Marsh Lane, West Ham, about 10 minutes' travelling distance from the college. Should a grant be received to buy a reactor a Jason Mk. III supplied by the Hawker Siddeley Nuclear Power Co., will be installed. As can be seen from the artist's impression of the completed reactor building it will be sited some distance from other buildings. It will be the first university reactor to have a licence for installation in the Greater London Area. Imperial College tentatively considered installing a reactor at Kensington but soon decided against the idea. They now have a licence for erecting one at Ascot. In America there are a number of precedents for constructing research reactors in built-up areas, as witness the CP-5 type reactor at M.I.T., Cambridge, Mass.

Permission has been given to the CEGB to build a 550 MW nuclear power station at Oldbury-on-Severn, 14 miles north of Bristol and 4½ miles downstream from Berkeley. The station is scheduled for operation by 1966. It will follow the present pattern of Magnox canning but could have a concrete presure vessel.

Northern Ireland's first nuclear station, when built, would now probably be sited on the coast and not in the Lough Neagh area as originally intended, it was recently disclosed in the Northern Ireland House of Commons. Reporting that a proposed site in the Lough Neagh area had been ruled out for public health and safety reasons, Lord Glentoran, Minister of Commerce, said that the Government were now looking for a coastal site. He asked for a supplementary vote of £11,000 to cover the cost of the appropriate investigations.

Manchester College of Science and Technology is holding a short course of lectures on "The Disposal of Waste from the Uses of Radioisotopes" on January 12-13. Details can be obtained from the Registrar.

The first major exhibition on nuclear energy held in Wales has been taking place at the Welsh College of Advanced Technology, Cardiff, where a three-part display was put on by the AEA.

Argentina

Government approval has been given to the bartering of 5 tons of "yellow cake" uranium concentrate by the Argentine Atomic Energy Commission with Nukem, of Germany, for uranium-processing equipment. Value of the exchange is given at about $U.S.70,000. Negotiations are under way for further barter arrangements of this kind. Nukem is sponsored by Degussa, the suppliers of the equipment in Argentina's uranium metallurgical plant at Ezezia.

Diversity on the Continent

TO THE international observer it is very noticeable that despite the smallness of the nuclear power programmes pursued on the continent of Europe there is a great deal of equipment of nuclear standard being manufactured there. Furthermore the diversity of the range of technologies being studied is impressive, particularly to any observer accustomed to the limited techniques that are followed in Britain. Examination of the European scene does in fact expose the narrowness of the British programme, though at the same time highlighting its intensity and strength. Readers are given an opportunity to make their own evaluation of the situation by referring to the specially prepared articles on Europe and European activities that appear elsewhere in this issue.

Australia

A 12 MeV Tandem Van de Graaff accelerator is being installed at the Australian National University, Canberra, at a cost of £A500,000. It has been supplied by High Voltage Engineering and is being assembled by staff of the university's Research School of Physical Sciences.

Concrete PV Decision Awaited

AS YET Electicite Electricite de France has not announced any decision as to the construction of EDF-3, although tenders for this gas-cooled, graphite-moderated reactor station were being considered during July (*Nuclear Engineering*, August, 1960, p. 335). The outcome of its deliberations is keenly awaited as three of the tenders were for designs incorporating concrete pressure vessels. British engineers have had their interest aroused in this comparatively novel use of concrete by two recent institution papers and it would be particularly interesting to see what effect EDF's decision would have on tenders submitted for Oldbury and the CEGB's attitude to them. Summaries of the two papers, "Prestressed Concrete Pressure Vessels at Marcoule," by J. Bellier and M. Tourasse, read to the Institution of Structural Engineers, and "Some Contributions from Nuclear Power to Engineering Practice," by I. Davidson, Institution of Civil Engineers, appear on page 586 of this issue.

Belgium

Installation of the "waisted" or "diabolo-shaped reactor vessel for BR-2 recently took place at Mol. Many scientific personalities attended.

Czechoslovakia

Prague was the scene recently of a week-long symposium organized by the IAEA on chemical effects of nuclear transformations. About 170 scientists from 24 countries attended, together with representatives of Euratom and the Joint Institute for Nuclear Research, Dubna, U.S.S.R.

Finland

Finnish State Power Board senior staff have been visiting England where they were shown Calder Hall and Bradwell.

France

French nuclear activities are to receive financial backing from the government during the coming year to the tune of NF2,175M (about £157.7M).

West Germany

There were 110,000 visitors to the 1960 Interkama at Dusseldorf, about 40% of them being from overseas. Out of the 470 exhibiting firms over 30 showed their latest developments in the field of reactor instrumentation.

The German Government has budgeted DM186M for expenditure on nuclear energy activities during 1961, together with a supplementary DM21.15M specially for predevelopment work on economic nuclear power stations. Of the DM186M. DM105M are to be spent or diverted to the support of scientific institutes working in nuclear energy, DM21.5M will go towards the Karlsruhe research centre, DM21.7M will be appropriated for the working expenses of the part-state-, part-industry-owned reactor company at Karlsruhe, DM15.4M for DESY, the German electron synchrotron project at Hamburg, DM8M towards furthering techniques on fuel processing and DM4M for radiation protection work. The supplementary budget is intended to cover the construction of research and prototype power reactors.

The former AKS of Stuttgart has been reformed into a new company with capital of DM1.5M. Called Kernkraftwerk Baden-Wurttemberg Planungsgessellschaft m.b.H. it is to carry out design, and economic studies of 150MW and 5MW power reactors for construction at Baden Wurttemberg. On the results of these studies it will be decided whether in fact a power station will be built of the OMR type.

Work has started on the Siemens-Argonaut reactor installation at Karlsruhe. Start of operation is scheduled for next autumn.

Plans for a nuclear ship being drawn up by Gesellschaft fur Kernernergie-Verwertung, Geesthacht, are expected to be ready early next year. It will be a 22,000 tonner and the 11 shipyards that have expressed interest will be able to use them as a basis for the design of a tanker, freighter or passenger ship. The hull is to be capable of incorporating a yearly succession of propulsion units starting with an OMR.

Italy

June 15-29, 1961, are the dates of the eighth international Nuclear and Electronics Congress and Exhibition organized by the Rassegna Internazional e Elettrica, Nucleare e della im Cinematografia, Rome. Venue: Rome.

India Specifies Reactor Station

The invitation from the Indian Department of Atomic Energy for tenders for a nuclear power station near Tarapur, some 60 miles north of Bombay (briefly reported in *Nuclear Engineering*, November, 1960), specifies that the station should have an electrical sent-out capacity of 300 MW "supplied from two nuclear reactors of equal capacity, operating with natural uranium as fuel." It further specifies that foreign exchange content of the price should be kept to a minimum and that the greatest possible use should be made of Indian materials, locally fabricated equipment, and Indian personnel. A later paragraph in the invitation says that tenderers who are not prepared to submit tenders for reactors using natural uranium as fuel can submit alternative proposals based on enriched fuel, "if, in their opinion, such proposals will achieve the objectives of the Purchaser." It is certain that the British nuclear power consortia will submit tenders. They have been showing an interest in the possibilities of nuclear power in India for some time now, an interest, however, that is tempered by the questions of finance that will certainly arise. It is believed that companies from Sweden, France, the United States and possibly Germany will also be tendering for the contract.

A team from the Tarapur nuclear power project, representing the Indian Atomic Energy Department at Hinkley Point. The group consists of (*from left to right*) Mr. M. N. Chakravarti, Mr. R. Wall (Hinkley Point site superintendent), Dr. M.R. Srinivasan, Mr.C.W. Amos (English Electric export officer), Mr. M. Dayal, Mr. R. A. Archer (English Electric, Bombay), and Mr. G. White (Taylor Woodrow).

Pakistan

The new capital city, Islamabad, is to have a nuclear research institute equipped with a swimming pool reactor costing just over £1M. This is the third reactor planned for Pakistan; so far nothing definite about any of them has been settled. Nuclear training centres are to be established in Lahore and Dacca, and there are also to be medical radioisotope centres at Karachi, Multna, Lahore and Dacca, and agricultural radioisotope centres at Dacca and Lyallspur. These centres, established on the recommendation of a recent IAEA mission, are scheduled for completion by the end of the next two years.

Philippines

IAEA experts have been studying the potentialities of nuclear power in the Philippines over the next decade. Their visit to the country arose from the findings of the IAEA preliminary assistance mission which went to the Philippines in May of last year.

South Africa

During the first nine months of 1960, South Africa exported materials prescribed under the Atomic Energy Act totalling £36,009,655, according to a preliminary trade statement from the customs and excise department. For the same period in 1959 the exports amounted to £36,611,716.

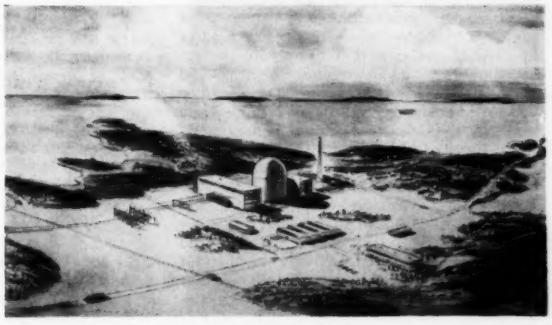
An offer of £100,000 has been made by the mining industry towards the cost of a nuclear accelerator and ancillary buildings for Witwatersrand University, Johannesburg. This is in addition to the £800,000 the industry recently contributed towards a fund for the development of nuclear research in South Africa.

South America

Forty-nine American firms have contributed to the AEC exhibits that are being shown in Buenos Aires, Argentina, and Lahore, Pakistan, this month. Later these exhibits will be shown in Brazil, Peru, Venezuela and the Lebanon.

Sweden

Government approval is sought by the State Power Board for the construction of a 100MW nuclear power station at Marviken, near Norrkoping. Previously known as the R4/Eve project, the plant will incorporate a heavy water pressurized reactor of the type designed for the Agesta station. Unlike the Agesta, however, the Marviken plant will be housed above ground. It is scheduled for completion in 1967.

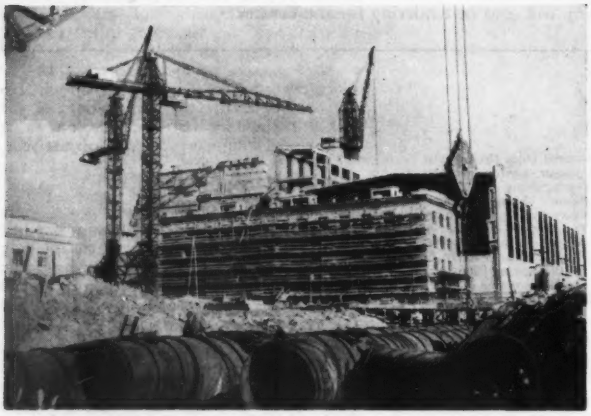


Artist's impression of the 100MW nuclear power station to be built at Marviken, Sweden.

Contractors for the Marviken station will be ASEA and Nohab who have completed the design in collaboration with AB Atomenergi. In spite of a close study of Canadian projects a pressure vessel system has been adopted in preference to a pressure tube.

Total of S.Kr.152M (about £10M) has been recommended as the amount to be allotted to atomic energy affairs by the government in its 1961-62 budget. This sum will go to meet the needs of the State Power Board and AB. Atomenergi. The Power Board needs S.Kr.30M for the Ågesta and Marviken power station projects.

U.S.S.R.



Work proceeds on the construction of the 200 MW Soviet Kurchatov nuclear power station at Beloarskye, near Sverdlovsk in the Urals. Due for completion in 1961 the station is based on a graphite-moderated water-steam-cooled reactor system incorporating a nuclear superheat feature. It was originally planned that initial output would be 400 MW e. This was later modified, though it is believed that present planned output would be expanded at a later date, if and when necessary.

Yugoslavia

The six scientists involved in the reactor accident at the Boris Kidric Institute, Yugoslavia, in 1958, received doses varying from approximately 207 rad to 436 rad, according to the report of an Oak Ridge team. They have also found that the gamma neutron ratio in the casualties varied between 3.5 to 1 and 4.2 to 1, according to their position in relation to the reactor. The team base their findings on the results of dosimetry measurements undertaken at a reconstruction of the accident held at the Institute earlier this year sponsored by the IAEA and in which several countries participated.

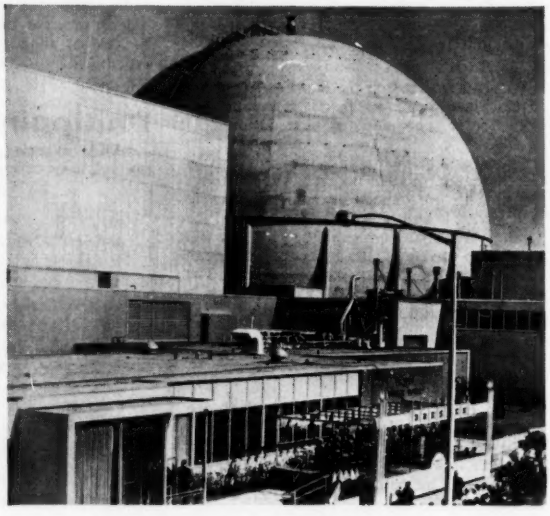
U.S.A.

Ground has been broken for the 17 MW pressure tube reactor plant to be built at Parr, South Carolina, for Carolinas Virginia Nuclear Power Associates. As in the NPD-2 plant under construction in Canada, the CVNPA reactor will be heavy water moderated and cooled, fuelled with natural uranium dispersed in pressure tubes instead of a pressure vessel. At Parr there will be 42 of these tubes, U-shaped and each weighing 750 lb and 4 in. in diameter and 19 ft. long. Unlike those in NPD they will be arranged vertically, the NPD tubes being horizontal. Scheduled for completion by mid-1962 the plant has been designed and developed by Westinghouse Electric Corporation. It is costing $28M to build and the U.S. AEC have spent $15M on it under their demonstration reactor programme for research development and other charges.

Nuclear explosion detection equipment based on an atmospheric fluorescence detection technique developed at Los Alamos is being tested by the AEC, J. A. McCone, Commission chairman, recently announced. The technique used has been proposed for inclusion in a world-wide network of ground stations for detection of nuclear explosions in space as discussed at Geneva.

The problems of rotary shaft sealing are the subject of a research programme just begun at the Battelle Memorial Institute, Columbus, Ohio. Sponsored by over a dozen American firms, the programme in the first year will be directed towards the study of high-speed liquid-lubricated face seals. Basic experimental data will be obtained, with special emphasis on the behaviour of primary seal elements.

Nuclear energy as a safe industry has been further emphasized by the AEC's announcement that three more major AEC plants have exceeded 10M man-hours of operation without loss of time due to personnel accidents. The three plants are the Y-12 enriched uranium factory operated by Union Carbide at Oak Ridge, the plutonium and irradiated fuel plant operated by General Electric at Hanford, and the weapons centre operated by Dow Chemical at Rocky Flats, Colorado.



Formal opening of the 180 MW Dresden BWR station was recently performed by AEC chairman, J. McCone.

Eighty-two scientists and engineers from 17 countries are taking the current course in nuclear training and research at the International Institute of Nuclear Science and Engineering, Argonne.

SIX MONTHS or more are being lopped off America's nuclear propelled rocket experiments—Project Rover—by cancelling the feasibility design study stage. The project will now move direct straight into the industrial research and development phase and a contract for this work is expected to be announced during the next two or three months. The first nuclear rocket should be flight-tested by 1965. *The move, decided upon by the AEC and NASA, results from the success encountered with the "Kiwi" experiments at Nevada.*

The Homogeneous Reactor Experiment No. 2 (HRE-2) at Oak Ridge has been resumed after a shut-down period of several months for modification and maintenance. Two small holes in the reactor core vessel had to be patched up and five diffuser screens cut up and removed. The reactor has been modified to reverse the flow of the uranyl sulphate solution that serves as fuel, moderator and coolant. The solution is now pumped from top to bottom through the reactor core vessel. This reversed flow is expected to prevent stagnant areas in the core vessel that could lead to "hot spots" causing possible melt through the vessel walls. This condition is believed to have caused the two holes that had to be patched up.

Los Alamos Scientific Laboratories are to build a reactor specially designed for the gasification of coal. Preheated helium will be passed through the reactor and heated to a temperature of 2,500°F. It will then be passed through a heat exchanger where it will react with a mixture of preheated coal and water. Coal gas is exhausted from the top of the exchanger.

Enrolments for the current advanced course on reactor technology at Oak Ridge numbered 27. The students, who mostly are engineers and scientists already associated with various reactor projects, come from nine different countries.

A neutron cross-section evaluation centre has been established at the Brookhaven National Laboratory to provide a centralized source of information on neutron cross-section data needed by reactor engineers, designers, and physicists. Cross-section measurements will be assessed at the centre and theoretical extrapolations of data made. In addition, the completeness of measurements on various materials will be determined. Information collated at the centre will be obtained mainly from U.S. AEC laboratories. Some will also come from other national and international organizations and groups.

The advanced helium gas recycle loop developed by the Bureau of Mines and the AEC, to investigate the technical feasibility of using nuclear heat for industrial processing, recently completed 1,000 hours of continuous operation at 2,500°F, 250 psi. This is considered a significant advance in the technology of high-temperature process heat systems and the potential application of nuclear reactors for this purpose.

A pulsing reactor is to be installed at the U.S. National Navy Medical Centre, Bethesda, Maryland, by General Dynamics for studying the effects of radiation on living organisms. It will be a specially adapted TRIGA reactor, similar to the one being supplied to the U.S. Army Diamond Ordnance Fuze Laboratories (*Nuclear Engineering*, Sept., 1960, p. 419), capable of a steady operation state of 100 kW or operation at 1,000 kW for periods of up to 10 minutes' duration. Higher power pulses of shorter duration are planned. Completion of the reactor is scheduled for September, 1961.

Construction permission has been given by the AEC to Pacific Gas and Electric for the 47.5MW BWR plant at Humboldt Bay, near Eureka, California. Designed by General Electric and Combustion Engineering it is to be built by Bechtel Corporation. It is scheduled for completion by 1962-63.

The Atomic Industrial Forum makes a return to the exhibition scene this year after an absence of three years by sponsoring the AtomFair-West at San Francisco from December 12-16. There are some 70 exhibitors at the fair and a gate of 7,500 visitors is expected. A review of the exhibits can be found on pages 565-567 of this issue.

Controlled thermonuclear reactions made news recently when Dr. F. H. Coensgen, at the Lawrence Radiation Laboratory, California University, announced that his team had confined deuterium plasma for a longer time and at a higher temperature than before. At the same time he was anxious to emphasize that this neither was a major breakthrough nor constituted a fully confirmed and identifiable thermonuclear reaction. He claimed that a small quantity of deuterium was confined in a magnetic mirror machine for about one thousandth of a second at a temperature of about 35M °C. During this confinement the release of 10,000 neutrons was observed.

Fifty-seven more patents taken out by the AEC have been made available for public use. This brings the total number of AEC-held patents and patent applications released for licensing to 2,438.

MSR Experiment for Oak Ridge

A MOLTEN SALT REACTOR is to be built by the U.S. AEC at Oak Ridge. With a design output of 10MW(t) it will be used to provide confirmation of earlier experimental work and information on components needed for a larger reactor. It will have a cylindrical graphite core about 4½ ft dia. and 5½ ft high. The molten salt fuel, a solution of Li-7, Be, U, Zr and Th. fluorides will be pumped through some 600 channels in the graphite columns that make up the core. Heat will be removed from the fuel solution in a primary heat exchanger that will use a mixture of Li and Be fluorides as the coolant. Molten salt fuels were originally developed for use in compact, high-temperature, high-power density reactors for nuclear aircraft propulsion and the MSRE, designation of the new reactor, will, in fact, be housed in a building previously used for the Aircraft Reactor Experiment which was dismantled in 1954. Commenting on the project, Dr. Alvin M. Weinberg, Oak Ridge director (*Nuclear Engineering*, October, p 464), says that the great advantage of the molten-salt system is that it allows one to burn any of the fissile materials at a very high thermal efficiency, and with extremely high burn-up. As thorium is soluble in the melt it should be possible to achieve rather high conversion ratios with a technology that is the same for core and blanket. The combination of very high thermal efficiency, high conversion ratio and very high burn-up gives the system the distinction of having perhaps the lowest calculated fuel cycle cost of any reactor—of the order of 0.5 mill/kWh. A further advantage seen by Dr. Weinberg is that with improvements the molten-salt concept could develop as a breeder system with a significant edge over the gas-cooled, solid-fuel system. Some idea as to the possibilities of the system will be solved, it is hoped, by the MSRE, the design of which is now being carried out by Burns and Roe. Construction is expected to be completed by 1962 and operation started early the following year.

An operating licence is to be issued by the AEC to the Washington University for an A.M.F. research reactor.

Work has been cancelled on the nuclear test plant (NTP) reactor scheduled for construction in the U.S. National Reactor Testing Station, Idaho Falls. The plant was to have been a water-cooled reactor system designed to facilitate full-scale testing of prototype military reactor cores and control systems, such as those for the SM-2. These will now have to be tested in operational field plants. Conceptual design of the NTP was being undertaken by Combustion Engineering and the architect-engineering work by C. F. Braun and Co.

First sub-critical assembly using enriched fuel to be installed in an American junior college is being supplied by Lockheed Nuclear Products, Atlanta, Georgia, for the Pensacola Junior College, Florida. It will contain two core reflectors, one of polythene and the other of graphite, and a "barrel"-type shielding that permits eight configurations using a single neutron source.

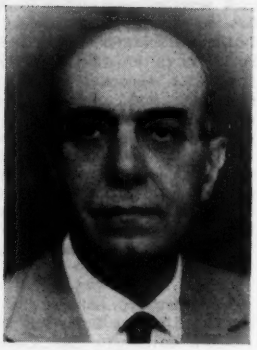
Illinois University's above-ground TRIGA was recently dedicated. One of the major facilities for the university's new nuclear engineering programme and also to be used for producing isotopes for other departments, the reactor is of similar design to the one installed at the Italian Nuclear Research Centre near Rome. There are some 20 TRIGA reactors in operation or under construction throughout the world. Except for these two they are, or will be, built below ground level. The Illinois reactor is enclosed in concrete shielding 22 ft high and 26 ft by 21½ ft in floor area and is equipped with a thermal column, four beam tubes and a bulk shielding experimental tank.

California University has installed an EDUCATOR-type reactor in its $500,000 nuclear research centre at Los Angeles. A light water graphite-moderated reactor using 3.3 kg of enriched uranium and having a power output of 10 kW(t), the EDUCATOR is based on the Argonaut-type of reactor. Designers and constructors are A.M.F. Atomics, in collaboration with General Nuclear Engineering.

Halden Steams

As reported in *Nuclear Engineering* last month the HBWR achieved its first boiling on October 5. Since then we have been sent this photograph to prove it!

Aims and Functions of Atomic Forums



by **Prof. Ing. CARLO MATTEINI**

(President, "Forum Atomique Europeen"—FORATOM)

NUCLEAR energy was first made manifest to the world as a weapon and at its beginning was used for destruction; this is its original sin. But now everybody should know that nuclear energy is a new form of fire, absolutely unknown before, which produces heat without combustion and without a flame, and that its influence on the march of mankind may well be compared to the invention of the wheel.

The advancement of science has been so rapid in this century that in many circumstances the normal human mentality has not had the time to adjust itself to the tremendous technological progress being achieved and to follow the trend of development of the so-called mechanical civilization. If we look at the most impressive discoveries we may see that about a century elapsed between the invention of the pile by Volta and the entry of electrical power into everyday life; almost 50 years were needed by aviation to go from the first timid flights to the use of planes as ordinary transportation means.

In three years—from 1939 to 1942—in the field of atomic power we went from the discovery of fission by Hahn to the first controlled chain reaction realized by Fermi in Chicago; then, in 1945, the frightful explosion of the first atomic bomb. But only a few years later the electrical power plant of Calder Hall in England began its peaceful operation.

Fear of contamination, military and peaceful uses heaping up together, political backgrounds, have confused the human mind, created the so-called "atomic fear" and a distrust in the use of atomic power, so there were even cases of populations almost insurgent against the construction of a nuclear power plant in their area. This means that it is necessary to counterfight and counterbalance what we defined as the original sin of the atom. The new energy needs new forms, new structures, a new spirit. We must help the common man, at every level, to understand the deepest sense of the use, and perhaps the misuse, of such a form of energy; we must show him its possibilities and capacities so as to convince him that its peaceful application is bringing progress, help and no inconvenience to human life.

Everything is new in this branch of science and of industry; consequently, to take advantage of its opportunities, it is necessary to solve many problems not only of a technological character, but also of a management, governmental, legal, financial and community relations nature.

Many or most of these opportunities and problems can be best identified and studied through the co-operative effort of all persons, agencies and organizations most interested in the subject: these considerations gave birth to an idea first realized, in late 1952, in the United States of America. There, several prominent individuals from industry and education met and promoted the creation of a "forum" intended to be, in the original Latin meaning of the word, a meeting place where ideas and opinions from all parties concerned could be expressed and exchanged, so that such a new form of association could play a useful rôle as atomic industry began to evolve.

The First Forums

Thus, in 1953, an Atomic Industrial Forum was established in the United States and now it plays an important part in American nuclear activities. This idea proved to be a very good one, and other associations soon followed the same line in different countries such as France, Belgium Luxembourg, Japan, Italy, Switzerland, Germany, etc. The Canadian Nuclear Association was founded last September. All these Associations or Forums have the same basic purpose: to provide a place of union and discussion for all agencies, institutions, industrial firms and individuals interested in the development of the peaceful uses of atomic energy in their particular country.

It must be noted that in several countries, commercial or professional Federations and Unions, acting in the nuclear field have emerged, which play a different rôle from the Associations or Forums. In effect, the Associations or Forums are highly diversified types of organization and do not deal with any particular Union, labour or commercial problem because their membership, as we repeat, is not limited to industrial groups, but has a much wider range. Moreover, they have a further and wider scope which, from the industrial viewpoint, can be summarized by the statement that they will, on a shorter or longer run, create a favourable climate to the development of an industry from which we all expect the energy of the future. Of course, although the Forums are not mainly concerned with financial or commercial problems of immediate interest, a collaboration among them and the industrial Federations will always be of mutual interest.

The Forums are generally established under the form of a non-profit membership association of public agencies, private bodies, industrial, financial and insurance concerns, research centres, university and educational institutions and also of individual scientists, engineers and professional men interested in the development and utilization of atomic energy for constructive purposes. The activities of these Associations take the form of national and international meetings, the working of special committees, the publication of bulletins, books and other means of information, the preparation of exhibitions, etc. One of the basic functions of these Associations is to maintain relations with and provide a counterpart to the national, international and supranational Agencies in the nuclear field as well as with the Associations of the same type existing throughout the world.

Nationally, the Associations act as a two-way bridge, linking on one side the official and scientific circles (creating thus a very useful contact between government, science and industry), and on the other, the general public (performing thus a very useful public relations function). Internationally, the need of such a qualified and independent counterpart was felt from its beginning by the Commission of Euratom which in its first yearly report (1958) welcomed the idea of the creation of a European Atomic Forum. The implementation and advisory possibilities of such a "Forum" are also widely recognized by the European Nuclear Energy Agency of the OEEC and by the International Atomic Energy Agency.

European Collaboration

For their part, the same need was felt by the six Forums and Associations of the European Community and they formed in Brussels on May 4, 1959, a "Comité de Contact." This "Comité de Contact" held several meetings in order to draft a common programme and to prepare the creation of the European organization. On July 12, 1960, the six Associations established in Paris the "Forum Atomique Européen" (FORATOM). As it had been unanimously decided that full membership should be open to all the national Associations of the European countries (while also the Associations of non-European countries will have the possibility of joining FORATOM as "Associate Members"), the application for membership of the *Association Suisse pour l'Energie Atomique* was immediately accepted, so that FORATOM has now seven members.

The six Associations which took the initiative in the establishment of FORATOM are listed here in the chronological order of their foundation:

Association Technique pour la Production et l'Utilisation de l'Energie Nucléaire (ATEN)—France,
Association Belge pour le Development Pacifique de l'Energie Atomique—Belgium,
Association Luxembourgeoise pour l'Utilisation Pacifique de l'Energie Atomique (ALUPA)—Luxembourg,
Forum Italiano dell'Energia Nucleare (FIEN)—Italy,
Deutsches Atomforum—Germany,
Reactor Centrum Nederland, representing for the present the participation of the Netherlands, where a Forum is being formed.

Contacts have already been made with interested parties in the U.K. and with the similar associations existing or in the process of being formed in the rest of Europe.

To give a more complete picture of the aims and of the structure of FORATOM, some of the more important articles of the by-laws which were unanimously adopted in Paris on July 12, 1960 are appended.

FORATOM is administered by a Steering Committee which consists of the Presidents (or Delegates of the Presidents) of the active member Associations. The President and the two Vice-Presidents of FORATOM are elected by the General Assembly from among the Steering Committee. As a rule, the President or Chairman is elected for one year and is replaced the following year by the first Vice-President, who, in turn, is succeeded by the second Vice-President, so that the Association has its continuity and a well-balanced guidance.

The responsibility for the implementation of the decisions of the Steering Committee is entrusted to an Executive Committee whose members are the Managers or Secretaries General of the active member Associations. From among this Committee a Secretary General and a Deputy Secretary General are appointed by the Steering Committee.

It must be noted that each member of the Steering Committee controls one vote, while in the General Assembly each active member is responsible for a number of votes, from one to four.

The Constitutive General Assembly has determined the number of votes assigned to each Association as follows:

ATEN, FIEN, Deutsches Atomforum .. 4 votes
Association Belge, Reactor Centrum Nederland, Association Suisse .. .. 2 votes
ALUPA .. .. 1 vote

so that the General Assembly of FORATOM counts now 19 votes.

The number of votes to be assigned to each new active member shall be determined by comparing with the numbers indicated above. Also the dues of the members follow a proportional scale.

The activities of FORATOM have just started and it is too early to outline them in detail. However, work is progressing on the preparation of the Paris Conference of 1962 during which the European countries will show what they have done to make the world benefit from the new source of energy. This Conference will not only have an information purpose, but it will also provide a meeting point, it will make possible and easier a large exchange of views and it will, at the same time, strengthen the ties among the different organizations and persons who see in the atom a new instrument of civilization and of progress.

We have formed FORATOM because we do believe in European and international co-operation particularly in the atomic field and we consider the new Organization, as well as the national Forums, as a foundation on which this co-operation can be established. We know that only in this way can the promise of atomic energy be brought to speedy fulfilment. We do not forget that our ultimate purpose is to redeem the atom from its original sin, so to renew the myth of Prometheus with the capture of a sparkle from a new and still mysterious fire.

Aims and Functions of FORATOM

The purpose of the new Organization is defined by Art. 2:

The Union, cognizant of the economic and social impact of the development of the peaceful applications of nuclear energy, shall have the purpose to develop a common action in order to coordinate and promote, on the international level, the activities performed by its members.

The means of action are listed in Art. 3:

Organize all types of meetings, discussions, expositions and, in particular, periodical Conferences, all of these meetings to be essentially for the purpose of better mutual information, create media or services capable of:

informing members of the Union on all problems related to nuclear energy,
maintain relations with third parties, notably the specialized organizations in the nuclear field,
establish documentation services capable of supplying its members with information concerning studies, and experience, research and investigations performed in the different branches of activity contemplated in keeping with the corporate purpose.

Establish Study Committees or Working Groups to be charged specifically with the examination of any questions which the Steering Committee may judge appropriate for inclusion in the agenda.

FORATOM has three categories of Members namely (Art. 5):

1. *Active Members*

Active Members shall be the national associations established in the European countries, whose purpose is similar to that of the associations listed in the Preamble and who are admitted by the General Assembly by virtue of their representative character and their activity in the respective countries.

There shall be no more than one active member for each country.

2. *Associate Members*

Associate Members shall be the national associations of countries other than those providing the active members and which, without fully meeting the requirements for active membership are, nevertheless, admitted by the General Assembly because of their interest in the peaceful applications of nuclear energy.

There shall be no more than one associate member for each country.

3. *Honorary Members*

Honorary Members shall be persons designated by the General Assembly upon proposal, if any, by the national association of their country for their high competence in the field of nuclear energy and their ability to render outstanding service to the Union.

Euratom · Germany
Switzerland · Sweden
Norway · Spain
Portugal · Denmark
Austria

Continental Round-up

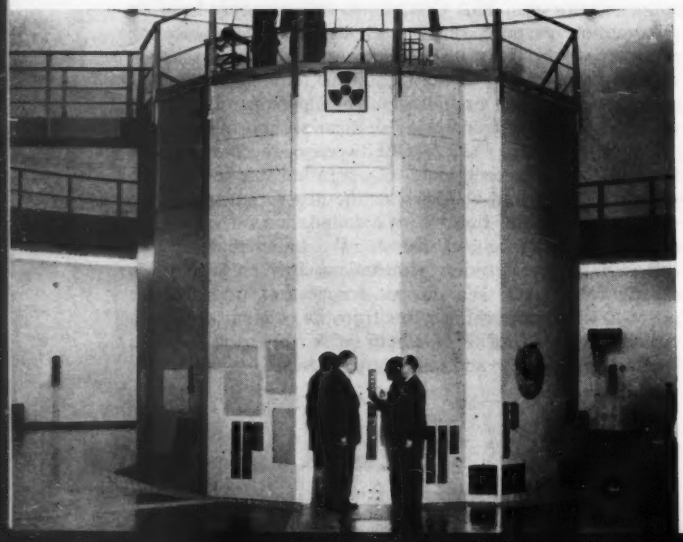
FOR most of the countries on the continent of Europe the great change in the conventional energy supply and cost pattern has required considerable re-thinking of atomic energy development programmes and has resulted in decelerations or changes in emphasis.

EURATOM

Against the background of the Three Wise Men predictions the formation of Euratom, the joint nuclear energy organization of the inner six, seemed not only economically and politically desirable but even technically an urgent necessity. There were many administrative problems in terms of safety regulations, licence and control, waste disposal etc., which required immediate action, and on the technical side the avoidance of duplication, the dissemination of information, the organization of construction fundings and the pooling of scientific competence were all charged with haste. The ultimate necessity for the administrative problems to be resolved and the desirability of organizing and co-ordinating technical effort is not denied, but the time scale is now different and it is only to be expected that some change has taken place in the emphasis which Euratom places on the various aspects of its mandate. It is unfortunate that as Euratom has increased in numbers and by its collaboration and information exchange agreements extended its field of influence, so at the same time has the call for positive action been reduced. In the long term this may prove to be no bad thing and Euratom will be permitted to evolve its policies and its practices in a gradual manner without being precipitate. The danger is that because the commercial pressures are lessened and there is no insistent demand for practical results in the immediate future, Euratom will evolve into a self-contained organization revolving on its own axis and providing little return for the countries contributing to its operations. Indeed, one at times suspects that some member nations encourage Euratom to become self-generating in order to protect their own special interests from interference.

The breakdown of the U.S./Euratom reactor building programme has emphasized the difficulty Euratom faces when trying to speak for the independent commercial organizations in the countries within its domain. Over the past two years there has been a noticeable withdrawal of private companies from the influence of Euratom and there is now less moral compulsion for such companies to undertake projects because from a European point of view they are desirable, or to invest their own money for the general good rather than that of their own shareholders. This applies equally to the independent companies of Germany and the nationalized companies such as EDF.

Euratom's nuclear facilities include this 5 MW heavy water research reactor (supplied by Allis Chalmers) at Ispra, N. Italy.



Change in Emphasis

Whereas the political unifying force of Euratom as a means of furthering the integration of the six has always been of major importance, it is this aspect that now is dominating and decisions on projects or policies are more likely to be motivated by political pressures than by technical considerations. It is not, of course, necessary that these should be in opposition and so far as internal relations within the six are concerned the swing in emphasis is relatively unimportant. It must however, have an influence on Euratom's attitude towards outside countries. They are still anxious that the United Kingdom should join the group but recognize now that this can only be as a part of the union with the Common Market, whereas in the beginning Britain could have joined without too strong commitments in the wider union. It is interesting in this context to note that the approaches announced by the Government in Parliament in the early summer were never in fact made to Euratom direct, nor was the U.K. AEA consulted, but were the result of some rather nebulous discussions in the general context of the Common Market.

But although the political significance of the organization may be dominant, a new phase in Euratom's history has now begun with the establishment of Ispra as a common centre. Euratom is intent on building up research teams of high competence able to undertake full-scale development work both in conjunction with and independent of other organizations. It has available an R and D fund of $75 million plus $15 million for power reactor assistance. Apart from the research projects aimed at the evaluation of detailed technologies Euratom is keen to develop whole reactor systems. Approval has already been given for the construction of a zero energy fast reactor and plans are proceeding for the development of the organic cooled heavy water moderated reactor system under the ORGEL project (Organique Eau Lourde). It should be noted here that the choice of the system was very largely influenced by the unwillingness of France to part with its experience on the heavy water moderated gas cooled reactor and of Siemens with its studies of a pressure tube heavy water reactor.

Apart from its own research projects Euratom has initiated a programme of sponsorship whereby projects are subsidized by Euratom. It is usual with such an arrangement for Euratom staff to join the research team concerned to ensure that results coming from the experiments are available to the member nations. How successful the dissemination not only of bare results but also of experience will be can only be assessed in the light of experience.

Changes in Patent Arrangements

Euratom has met considerable difficulty in persuading commercial organizations to undertake work which is liable to lead to patentable information, because of companies' unwillingness to devote great effort to the evaluation of techniques which will then be made public. As a result of this Euratom is preparing to adopt a much more flexible approach to the question of patents and is exploring ways of satisfying companies' requirements on the one hand and the terms of their Treaty on the other. The interpretation of the Treaty may take such a form as granting contracting companies ownership rights to the patents resulting from the work done whether this be assisted or entirely sponsored by Euratom, leaving Euratom the right to grant licences. This right would

only be exercised if an applicant for a licence failed to reach agreement with the contractor direct. Even in this case it is probable that Euratom would ensure that the contractor had some positive formal advantages in addition to the know-how that it would already have acquired. It is possible that the final terms will be somewhat similar to those adopted by the U.K. AEA in relation to some of its development contractors. Acceptance of such a scheme would clearly simplify Euratom's own internal problems but it would further complicate discussions with the Americans on the implementation of the U.S./Euratom development programme. Euratom appears to feel that the American system of licences being granted free by the AEC will ultimately have to be altered, although presumably some reciprocal arrangement such as exists between the AEA and the U.S. AEC could in theory be practised.

For the first time Euratom has also become involved in the straight purchase of equipment and is experiencing the problems (and advantages) of international tendering. It is interesting to note ENEA's experience on Dragon that calling for international tenders results in considerable price cutting, but Euratom will have to be careful to ensure a reasonable distribution of effort around the community. The purchase of equipment for its laboratories is, however, now a pressing matter and Euratom does not feel itself committed to buying only within the Community. It is quite prepared to go outside if sale conditions and delivery times are advantageous. Its stated policy, at present, is to purchase outside the Community if equipment is standardly available, rather than underwrite the development of such equipment internally. There is some reluctance to come to the United Kingdom for certain items but this is not as a result of political considerations so much as an impression that delivery schedules quoted by British manufacturers are frequently not met.

Ship Propulsion

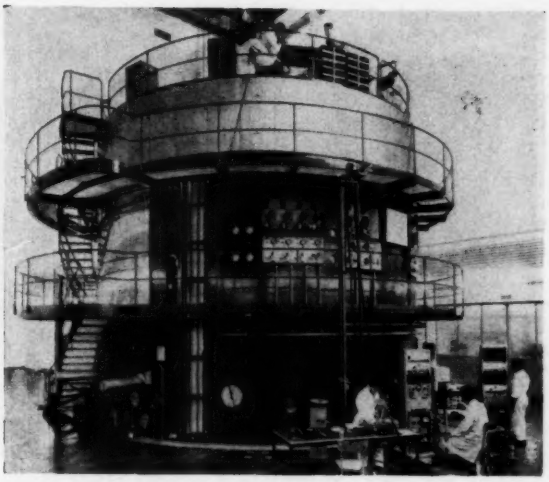
Apart from its land-based experimental programme Euratom is also concerned with ship propulsion and is seeking for 1961 a sum of $3 million for grants during the period with a further $3 million earmarked for future spending. Several marine projects are under consideration or scheduled for presentation. The GKSS-Interatom project for research and development work on a hull design and an organic moderated reactor with Euratom participation to the extent of DM 14 million has been discussed but this has led to a serious split inside GKSS which was already being attacked by other German organizations. As a result the probable outcome is in considerable doubt but Euratom is still hopeful that the work can go ahead.

Comparative feasibility studies have been conducted for the CEA in France on BWR, PWR and GCR systems. The technical studies were concluded early in 1958 and the economic studies in the middle of the same year. As a result of these the CEA decided to pursue further the Indatom concept of a vertical AGR and the company was asked to do further work. The CEA as a result have evolved the Pile au Moyen Température Project which is now being discussed with Euratom. Co-operation would be on the detail design leading to construction of a 25 MWt land prototype.

In Italy, Fiat in association with Ansaldo and Westinghouse are anxious to see a nuclear ship put to sea as soon as possible and have been conducting comparative studies of a PWR, BWR and a natural circulation PWR with a view to selecting the most suitable design which can be based on present day technology. They will be submitting to Euratom shortly a proposal for a final 18 months to two years R and D programme with a view to the construction of a ship.

The Netherlands have also indicated that they will probably be forwarding a proposal to Euratom for development work, feasibility and R and D studies relating to a ship unit, probably based on a 60 MWt PWR, and BelgoNucléaire from Belgium is completing the initial designs of a water reactor for submission to Euratom also at the end of the year.

More details of the activities of the atomic energy organizations within the community are discussed in subsequent pages. The structure of the industry in Germany has previously been analysed in *Nuclear Engineering* (see pp. 113-115, March, 1960) and it must suffice merely to supplement this comment with additional notes.



The 20 MW materials testing reactor at Würenlingen. The reactor forms the main experimental tool of the Federal Institute of Nuclear Research which is now run by the Swiss Confederation.

GERMANY

OF all the major industrial countries with atomic energy commitments, development work in Germany is probably the least well organized. The Government is unable to finance construction projects although it can give assistance to research undertakings. As a result, although within the German industry, particularly through its association with American and British companies, there is the capability of constructing power reactors and a great deal of contract work has been received from countries abroad, there seems no way at the present time of raising sufficient finance for large-scale work to be undertaken. The utilities are most reluctant to spend shareholders' money on large capital adventures, particularly when it is known that the running costs will be in excess of those of conventional stations and, indeed, under the German energy law which compels utilities to provide power with maximum availability at minimum cost the utilities can claim that the law prevents them from entering into any very long-term capital commitments. There is a strong tradition in Germany for industrial research and development to be independent of any Government interference and this, coupled with the independent attitude of the various Länder, results in a bit-piece form of development in which little co-operation between the various organizations can take place. Furthermore, because of the inevitable smallness of teams many of the major problems in getting a nuclear power programme under way are hidden and the magnitude of the problems that must be surmounted are underestimated.

At the same time, in order to promote development along a particular line, the Government must resort to expediences which are not necessarily economically or technically desirable. This is the background to the proposal that a ship's hull be constructed for the testing of various marine reactors which would be installed and then removed to give place to others. The Government is quite anxious for a nuclear propulsion programme to get under way and would like to see a ship built, but is prevented from openly subsidizing a construction project and is trying to dress it in the guise of research. Initially companies were reluctant to co-operate in preparing plans for nuclear ships until GKSS (one-third government financed) with Interatom began their work on the OMR. Reactions followed in industry and representations were made to get the Government support withheld until the alternative systems could catch up. The competitors are Siemens' PWR, AEG's BWR, Babcock's GCR and BBC-Krupp's HTGC. These studies, however, cannot be completed until the end of next year by which time the Euratom sponsored programme may be flourishing.

Tunnel to the reactor hall of the Ågesta nuclear station at Farsta near Stockholm.

Many people in Germany would like to see the land power programme put on a more solid basis and for means to be found for power reactors of significant size to be built, but no formula for organizing this has yet been proposed. Even the AKS OMR project could not get under way and the company has now been changed into Kernkraftwerk Baden-Württemberg Planungsgesellschaft m.b.H. who are to have prepared detailed designs and estimates for a 150 MW and a 15 MW station before making further decisions. The 1961 budget of DM 186 million to include DM 105 million for the support of scientific institutes, plus a special vote of DM 21 million including DM 12 million for assistance to heavy water pressure tube reactor research, DM 0.8 million for gas cooled and a similar sum for a BWR with superheat, does make provision of DM 4-5 million for the pebble bed prototype and DM 5 million for a 50 MW MTR, but the suggestion of the Minister that the aim should be for the development of small export type reactors is no more than a cover for the inadequacy of the present financing arrangements.

SWITZERLAND

IN the centre of the Community but outside its borders lies Switzerland which, like Germany, has also a long established background of independent research and development by industry without Government interference. Here, however, a more reasonable compromise has been evolved and is resulting in the joint participation of the Government and industry in research and development leading to a power reactor programme. There is no Swiss atomic energy commission as such as several Government offices and commissions are responsible for the different aspects.

The Federal Post and Railway Department which is also responsible for energy problems is the competent Ministry for atomic energy and in particular for granting permission to construct and operate nuclear plants (the Atomic Energy Law, December 23, 1959). The Department also controls transport, distribution, export and import of fissile material and the disposal of radioactive waste. To the Department answers the Federal Commission for the Safety of Nuclear Plant and the Delegate of the Federal Government for Atomic Energy Questions.

The Commission is a technical committee appointed by the Federal Government to supervise the construction and operation of nuclear facilities and, moreover, it advises the Government on all relevant safety questions. The Delegate is required to promote and co-ordinate all development efforts and to advise the Government on such matters as the law, research, scientific and technical training, co-operation between authorities and industry, the financing of reactor projects and international collaboration.

The Federal Commission for Atomic Science is a committee of the Swiss National Fund for Scientific Research and is composed of scientific, technical and governmental representatives. It promotes basic research in nuclear science and the training of scientists by allocating subsidies; at the same time, it co-ordinates to a limited extent the scientific work at Swiss universities.

Active research and construction on reactors was initiated by Réacteur S.A., a combine of a very large number of industrial organizations. This organization was responsible for the construction of SAPHIR, which came into operation in 1957, and the materials testing reactor DIORIT, which began operation in the summer of this year. This construction was made possible by grants from the Federal Government but it became clear that a closer integration of Government industrial interest was required for the successful development of reactor techniques. As a result the establishment at Würenlingen, the Federal Institute for Nuclear Research, which houses the two reactors was taken over by the Confederation and Würenlingen is now the national research and experimental centre with its facilities available to industry. In addition to its own research Switzerland is also participating in the ENEA's projects, Halden, Dragon and Eurochemic, it is a member of CERN and also of the IAEA. In addition, it has signed collaboration agreements with the United States (1957), France (1958) and Canada (1958).

For the actual construction of power reactors three groups were formed: the Consortium pour la Construction d'une Centrale Atomique de Recherche (Consortium), l'Energie Nucléaire S.A. (ENUSA) and Suisatom S.A., which together comprise almost the whole of the interested organizations in Switzerland. Consortium is made up of the big groups in the German part of Switzerland (such as Contraves, Escher-Wyss, Oerlikon, Sulzer, Brown-Boveri) and the provisional plan was to construct a 30 MW heavy water moderated reactor, if possible using natural uranium. ENUSA is comprised of companies from several cantons of the Suisse Romande and planned a 5 MW BWR. Suisatom, made up of four large electrical companies in the north, envisaged the purchase of a 27 MW BWR from a foreign supplier and was proposing to undertake this project entirely from its own resources. More recently it would appear that the three groups will combine together to construct with Federal assistance the power plant proposed by Consortium.

In addition to the specific reactor projects, development is also proceeding within the individual industries; for example, the aluminium industry is intimately concerned with the development of SAP as a canning material and for many years Escher-Wyss has been a pioneer in regard to the possible use of a closed cycle gas turbine for incorporation in a HTGCR circuit. U.S. companies have regarded Switzerland as a convenient base for a European H.Q. and General Dynamics has set up a research and marketing organization, and AMF and A.I. a sales office. Many companies also have close relations with overseas concerns; for example, Brown-Boveri through its connections with Richardsons-Westgarth is contributing to the Trawsfynydd power station in Wales.

SWEDEN

IN terms of specific building plans, Sweden has one of the most impressive programmes per capita of any country in the world. The status of developments was reviewed in *Nuclear Engineering* (May, 1960) but since that date two important moves have been made in that the AKK project for a 50-MWe enriched BWR has been approved by the Government and the State Power Board has applied for permission to proceed with construction of the Marviken station of 100 MWe which will be a development of Ågesta, i.e., a pressure vessel D_2O reactor, for completion in 1967. There is keen competition between these two utility organizations, and Swedish industry, notably in the shape of ASEA, has deliberately geared itself to providing manufacturing facilities to serve different approaches to reactor construction. The country does depend on outside supplies of enriched fuel and for certain specialist equipment such as instrumentation.

NORWAY

ACROSS the border in Norway (see *Nuclear Engineering*, February, 1959) there is no immediate requirement for nuclear power but there is none the less an anxiety to be in the forefront of developments in the event of nuclear propulsion

becoming a commercial proposition for merchant ships. This is the prime concern of the Institutt for Atomenergi which was founded in 1948 as a non-profit-making organization by the Government who contributed Kr. 5 million to the initial cost; contributions were also made by industrial organizations. Its main research establishment is at Kjeller and it is primarily operated by Government funds but industry is persuaded to contribute to specific projects in terms of money and materials. Operating expenses of the establishment work out at roughly £1.1 million per annum. Kjeller houses the heavy water critical assembly JEEP 1 (which first went critical in July, 1951), and finance for a second heavy water reactor of a few MW power, JEEP II, has been agreed although work has not yet been started. In addition the versatile facility NORA which is designed for reactor physics experiments on a variety of lattices and a variety of moderators is due for completion early next year. This reactor has been offered to the IAEA for collaborative research work.

Kjeller is still nominally the headquarters of JENER, the Joint Establishment for Nuclear Energy Research. Established in 1951 as a Norwegian/Dutch training centre there is still a high measure of co-operation between the two countries but the formal activities of JENER have virtually ceased and collaboration takes the form of assistance in each other's projects when this is mutually desirable.

The Atomic Energy Council is a Government advisory body but carries no executive powers.

The boiling heavy water reactor at Halden which was built by IFA is now operated internationally under the auspices of ENEA. Although it is intended that process steam from this installation should operate a paper mill the experience that construction and operation has given is considered more relevant to the central theme of ship propulsion. To date, however, no formal ship construction programme has been established although various propositions are being evaluated by a working party, 60% financed by the Government through IFA and 40% by the ship owners and other interested industrial organizations who have established for this purpose a society called REDERIATOM. It is expected that formal decisions will be taken next year on the construction policy but the method of financing such construction has still to be worked out. Apart from the fact that the moderator would certainly be water (although not necessarily heavy water) it is not certain what type of reactor system would be adopted, although indications are that a BWR would be preferred. Industry and business interests have also formed a company, NORATOM, for the construction of reactor plant and it is this organization that is responsible for the building of NORA.

To a large extent the industry has been able to make itself independent of outside suppliers although the contract for the second core for Halden was given to ASEA of Sweden, who, incidentally, sub-contracted back to Norway part of the development work. A fuel fabrication line has been built at Kjeller and is capable of undertaking the necessary manufacture for future projects. Norway will, however, still require to go outside for certain specialist components, for example, submersible pumps and other items where the small demand would not justify commercial development.

SPAIN

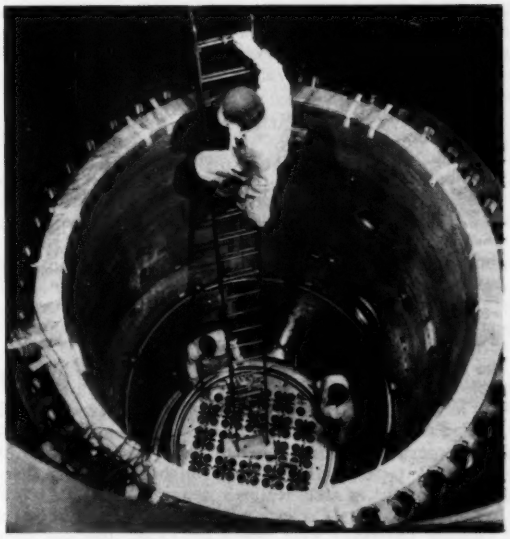
IN the Iberian peninsula developments in atomic energy have been considerably slower than in the rest of Western Europe. In Spain at the present time active experimental work is confined to the Junta de Energía Nuclear which has established at the University of Madrid a swimming pool reactor for training and post-graduate research. The greatest emphasis has been placed on the development of uranium deposits and a plant has been set up for the extraction of ore. A great deal of the effort of the Junta has been devoted to this aspect of development but more recently attention has been diverted to the evaluation of reactor systems and an agreement has been reached with Atomics International for the design study of a 30 MW experimental organic moderated plant. This will have a separately cooled centre section for fuel element testing.

In spite of the Government lead it is anticipated that all processes will eventually be taken over by private industry. Power generation is also the responsibility of private utilities, the two main combines being CENUSA covering Madrid and Seville and NUCLENOR in the north. To date the manufacturing industry has had little work to do but associated respectively with the two utility groups named, are two manufacturing consortia, TECNATOM S.A. and CONUSA S.A. Thus by means of overseas visits and design studies they are building up experience in nuclear technology with a view to undertaking plant design and project work as and when the time comes. Present plans call for the first power reactor of 250 MWe to come into operation in 1968, followed by two others at two-yearly intervals.

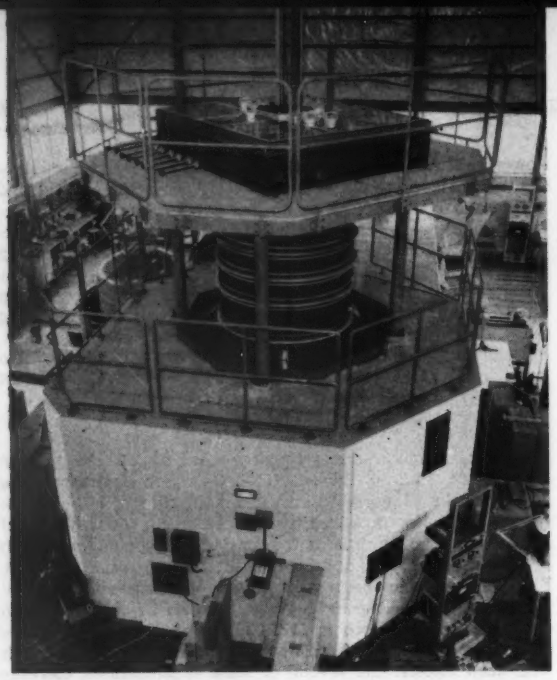
PORTUGAL

IN Portugal nuclear energy research is the responsibility of the Junta de Energía Nuclear (JEN) which is responsible directly to the Prime Minister. The main tasks of JEN are the survey of nuclear ores and their development, the training of technologists and a limited amount of fundamental research at the Nuclear Physics and Engineering Laboratory near Lisbon. The equipment includes a swimming pool reactor and a 2 MeV Van der Graaf machine. A rough estimate of expenditure on nuclear energy research is £125,000 per year. The electricity generating organizations are watching world-wide developments with keen interest and several of these organizations, totalling some 90% of the overall production and distribution networks, in association with the biggest industrial organizations formed Companhia Portuguesa de Indústrias Nucleares (1958) which is actively engaged on the study of the industrial and network problems connected with the introduction of nuclear power into Portugal. This is essentially a long-term project as hydro power resources look good until at least 1975. As a result no firm decisions as to the type of system to be adopted will be taken until the early 1970s, but in the meantime, there is a feeling that experience should be gained in nuclear technology and it is proposed to construct a 30 MW power station to come into operation in 1965/66.

Whilst in the early phases Portugal must depend almost entirely upon outside experience it is anticipated that when the nuclear programme gets under way, local industries will be able to provide 40-50% of a given installation although such specialist items as fuel rods, control rods, charge and discharge machinery, reactor instrumentation, valves, pumps, compressors and generators are likely to be imported for a long time to come. As with Spain, however, the balance of payments situation can be overriding in considering both reactor types and the extent of construction.



The first West German power reactor (supplied by General Electric of U.S.A.) went critical at Kahl on November 14.



DR-1, a small homogeneous reactor at Risø was purchased by the Danish AEC from Atomics International.

DENMARK

By H. R. VON BULOW, M.A.(Econ.)
(Principal officer, Danish AEC)

ESTABLISHED by law in December, 1955, the Danish Atomic Energy Commission was entrusted with the promotion of the peaceful uses of atomic energy for the benefit of the community. In the five years since its establishment the Commission has set up the Risø Research Establishment and initiated a broad programme of training, research and development, bearing on many different aspects of the use of nuclear energy.

Represented on the Commission are the sciences involved as well as the power companies and industry. Thus the interests most directly concerned are themselves at the head of the Commission's work. It is therefore also a guiding principle throughout, that Risø will co-operate to the fullest extent possible with other educational and scientific institutions and with industry and power companies.

Appropriations for the Commission's activities are voted each year on the finance bills. By April, 1961, a total of £7 million will have been invested at Risø. The current net expenditures for 1960-61 total £1.8 million. No net increase is foreseen for fiscal year 1961-62. About one-tenth of the budget relates directly to Denmark's participation in international atomic co-operation.

Today Risø has in operation three research reactors, an accelerator for food irradiation and physical experiments, two Co^{60} irradiation installations, as well as several laboratories, lecture hall, library, etc. Furthermore, a hot-cell facility and a metallurgy hall are under construction. The staff numbers 578, of which 136 are university graduated scientists and engineers.

There are limits to what can be achieved in the broad field of nuclear energy at a research establishment of Risø's size, but the establishment can and does serve as the centre of research and development in this field in Denmark and as the base for international collaboration.

The Commission's reactor research programme is based on the selection of a number of power reactor types, only one of which, however, for reasons of economy and manpower could be singled out for design study at Risø. A deuterium moderated organic cooled reactor—DOR—was finally selected for studies and experiments based on a collaborative effort involving several of the various research departments at Risø. The main criteria behind the selection of DOR may be quoted from the recently published Risø report on DOR: the fuel should be natural or possibly slightly enriched uranium, the design should not be based on very advanced or undeveloped techniques and the main components should be such as could be manufactured by Danish industry. Finally the reactor should be of a type not already extensively developed elsewhere and yet reasonably promising for competitive power production.

Caution should be applied in evaluating the fact that a particular reactor type has been selected by the Commission for a feasibility study, the purpose of which is primarily the exercise itself. Also, the Commission hopes to acquire diversity in its reactor knowledge by virtue of its participation with money and staff in the Halden boiling water project and the Dragon high temperature gas cooled reactor project, as well as from experiments which will be carried out in co-operation with the U.K. AEA. Similarly, in the field of fuel reprocessing the Commission relies on its participation in Eurochemic.

The possibilities of economic use of nuclear power production in Denmark can only be discussed in the light of the special conditions prevailing. Practically speaking, all energy demands in Denmark are satisfied by imports and the power utilities base their production on purchasing fuel wherever it is most economical; today the utilities' average fuel costs are less than 30d per million B.t.u. The *per capita* consumption of electric power is growing rapidly but is still somewhat below the average for Europe, and due to large daily and seasonal fluctuation in electricity demand the system load factor is on the average quite low. The future of nuclear power in Denmark will depend largely on the development of reactor technology and on the factors mentioned above, the decision as to when and how to introduce nuclear power resting with the utility companies themselves.

The power utilities have as yet no public plans for installing nuclear power in Denmark, but as members of the Commission and of Danatom the power utilities follow developments as closely as possible. Founded in 1956, Danatom is an association of some 50 shipbuilding and shipowning companies, electricity producers and industrial firms, which carries out general studies in the field of nuclear engineering in order to assist the members in acquiring knowledge in this field. A first study based on a Calder Hall type station has been completed and a second study concerning a boiling water nuclear power station is under way. In the field of ship propulsion an information study has also been completed.

AUSTRIA

EXCEPT for a tentative plan put out in 1959 by the Austrian Electric Company (Osterreichische Elektrizitatswirtschaft A.G.) to build a graphite moderated gas cooled reactor with a 100-150 MWe output sometime between 1966 and 1968 there has been little to indicate that Austria is interested in large-scale nuclear power generation. Perhaps something more definite will materialize from the 18 MW power reactor design study sponsored by the Austrian Atomic Energy Study Company (SGAE). Tenders for this study have been received from overseas countries and it is believed that if the lowest bid is accepted the contract will go to a German firm.

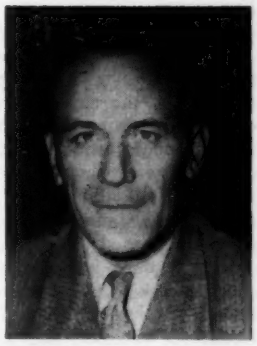
SGAE is a semi-public company, 51% of its capital being held by the Government and the rest by industry. It was formed in 1956 for the purpose of contributing to the development of a nuclear generating programme. Its principal achievement to date has been to establish the nuclear research centre at Siebersdorf, near Vienna, the focal point of which is an AMF 5 MW pool type reactor (ASTRA). Financing of this project was borne three-quarters by the State and one quarter by industry, funds loaned by the U.S. playing a considerable rôle in the Government contribution. As a means of encouraging industry to participate in the SGAE programme tax concessions have been made.

In Vienna the Ministry of Education has set up a research centre equipped with a TRIGA reactor and it is planned to install during the next few years a materials testing reactor. This centre is financed out of Government funds.

Over and above these two major Austrian projects, activity in the nuclear field is principally confined to studies and research undertaken by industrial teams. Earlier this year the Austrochematom Kernbrennstoff was established at Linz, an international company formed for the purpose of manufacturing fuel elements. The sponsors are Rio Tinto, Degüssa and an Austrian company.

Austria also contributes to the three OEEC projects.

The French Nuclear Industry



by M. H. ZIEGLER
(*President, A.T.E.N.*)

IN France, as throughout the rest of the world, after an initial period of vigorous activity, there has come a pause in the nuclear power programme. As Mr. Sterling Cole said at the 4th Ordinary Session of the General Conference of the IEAE, "the idealism felt at the time of the 1st International Conference on the Peaceful Uses of Atomic Energy has now given place to the realization of material possibilities, and we know that the applications of atomic energy require long years of study, research, perfecting and modification before they become universal and profitable." Thus, now is a time for reflection. We are given the opportunity to prepare conditions for the better utilization of the new energy source, whilst further scientific and technological progress is made, and while the numbers of engineers and technicians increase every year.

Against this background the research and construction which constitute the French nuclear programme are evolving. Three organizations or institutions form its basis: The Commissariat à l'Energie Atomique, Electricité de France, and Industry, this last comprising all the industrial concerns active in the field.

The CEA has played, and continues to play, the dominant rôle in the defining of programmes, the organization and allocation of projects, and in research and experimentation. In this last respect the essential work is carried out in its own establishments.

Electricité de France, which virtually monopolizes the production and distribution of electrical energy, has taken charge of the construction of nuclear power stations, itself directing, with the co-operation of important industrial groups, relevant studies and the actual building. At the same time research and experimental reactors are under the supervision of the CEA and the two organizations co-operate closely.

Whilst these bodies define general policy and assume in principle the rôle of Maître d'Oeuvre in the large projects, industry has from the beginning been called upon to co-operate and take an increasing part in the realization of the programmes of the CEA and EDF, this co-operation being apparent in the fields of both study and construction.

Industrial Effort

Industry participates in all stages of the production cycle from the extraction and conversion of the mineral to the manufacture of the fuel and the fabrication of the complete plant. To do this it has successively modified existing facilities or in some cases created highly specialized atomic energy divisions. Furthermore, with the construction of nuclear reactors, requiring the close co-operation in the different disciplines of chemical, mechanical, electrical, electronic and civil engineering, companies specializing in these different spheres have combined to co-operate, in groups such as France-Atome, or have established study groups of which Indatom is the first and the most important, or have set up specialized undertakings, of which they are both members and directors, such as Auxi-Atome, CARATOM, C.E.R.C.E., C.F.M.U., DYNATOM, FRAMATOME, G.A.A.A., S.I.C.N., S.R.T.I., etc.

One can obtain an idea of the significance of industrial participation when one appreciates that the number of companies which have taken part in the construction of French installations is about 1,000, and the rising nuclear turnover figure is now of the order of NF 1,500 million per year, equivalent to £100 million. Such a turnover figure is still very low in terms of the country's industrial potential; in other fields, such as car manufacture, the figure is very much higher.

Associations

To give a complete picture of the structure of the French nuclear complex it is necessary to mention organizations which have been created to help, represent or co-ordinate the activities of the various industrial elements.

The Association Technique pour la production et l'utilisation de l'Energie Nucléaire (A.T.E.N.) was first founded under the auspices of the CEA and EDF, to provide a central information service for its associates and for the public, and in this capacity to organize and co-ordinate participation at conferences, congresses and exhibitions. Its members comprise the majority of those industrial companies interested in the development of nuclear energy, as well as private individuals and groups with an interest in the scientific, economic or social aspects of peaceful nuclear development. To enlarge its field of activities, and to co-ordinate them with those of analogous associations existing in several European countries, A.T.E.N. has recently taken part (July) with six other associations of the same type, in the founding of the European Atomic Forum (FORATOM, see page 540).

French industrial companies have also grouped themselves into an organization to cover trade interests—the Groupe Intersyndical de l'Industrie Nucléaire (G.I.I.N.). This deals particularly with such questions as insurance, customs duties, industrial ownership, etc.

The CEA, EDF and a significant number of industrial companies have, in addition, formed a society called BREVATOM, which essentially deals with all patents relating to the application of nuclear energy emanating from the CEA and EDF and their industrial exploitation. In this capacity it produces an extremely detailed record of patents not only for France, but also for all the important countries. Finally, this society undertakes to protect in a general way its associates' industrial proprietary rights, watching for infringements of its members' patents.

Experience

The work undertaken by French concerns over the past 15 years has enabled them to acquire expertise in the country's fields of study, particularly in regard to power reactors of the natural uranium, graphite moderated gas cooled type. But other technologies are now being tackled with the construction of the Ardennes power station (PWR) and the gas-cooled heavy water reactor to be built in Brittany. In addition to these power reactors, there is also a whole range of research reactors, several of which can be regarded as advanced prototypes.

Such projects have been made possible by the efforts of companies who today are capable of supplying materials, fabrications, monitoring and control equipment, instruments for research and materials testing as used in the construction of nuclear installations of all kinds; i.e., from components required for laboratory work to complete research and power reactors, not forgetting factories for the processing of every type of material.

For example, special materials currently available include:

Fissile and fertile elements; uranium and thorium (in metal, oxide and carbide forms) under the control, of course, of the CEA.

Solid and liquid moderators; graphite, beryllium, beryllium oxide, heavy water, organics.

Heat transfer fluids.

Structural and canning materials (stainless steel, special aluminium and magnesium alloys, beryllium, zirconium, niobium, ceramics, cermets, sintered powders, etc.).

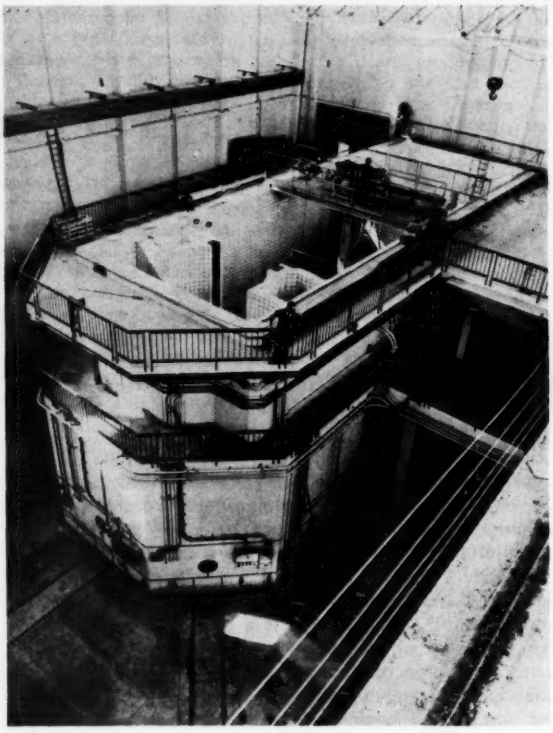
Shielding materials, radiation resistant lubricants.

Metals (magnesium and calcium, for example) of high-grade purity for the reduction of fissile materials.

Heavy concrete, special glasses, etc.

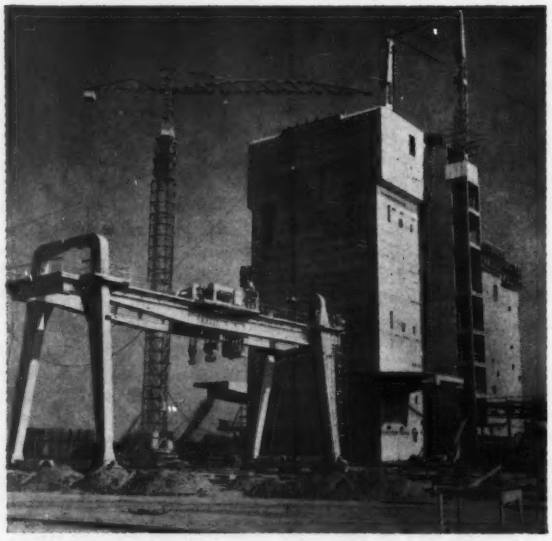
On the fabrication side, industry has experience in the construction of steel and prestressed concrete pressure vessels, charge and discharge gear (capable of operating with the reactor on load), circulators, pumps, measurement and control instrumentation, detectors, etc., etc.

In addition to this list of activities, the part played by the research organizations should be emphasized, and in particular of the groups formed to undertake complete projects including power stations and other nuclear plant. Such groups are today in a position to meet the demands not only of our own country, but also those made by neighbouring countries or international organizations, assisted by the CEA and EDF.



The swimming pool reactor TRITON designed by Indatom.

Among the most recent projects, that of the power station at Chooz, within the framework of Euratom's programmes, and entrusted to FRAMATOME in conjunction with Westinghouse, U.S.A., is an illustration of the potentialities of industry and the opportunities offered by collaboration with an organization in a neighbouring country. French industry has also co-operated with OEEC, in particular, in the construction of Eurochemic's factory.



EDF-1 reactor and heat exchanger building at Chinon.

A recent aerial view of Saclay.

Liability for Nuclear Risks

by JERRY L. WEINSTEIN[1]
(Counsellor, OEEC European Nuclear Energy Agency)

THE need for special legal rules concerning nuclear third party liability, and for harmonizing these rules throughout Europe, has long been widely accepted. This need stems from the risk, however slight, that damage of catastrophic proportions might result from an incident[2] during the operation of a reactor or other nuclear installation. Such an incident could impose enormous losses both upon the public exposed to injury and upon those operating and supplying the installation.

Persons who might be thus subjected to very heavy claims for compensation cannot protect themselves by taking out liability insurance, for unlimited financial protection is just not available. How, then, should the risk be divided? What proportion should be borne by the operator or those associated with the operation of a nuclear installation, how much by members of the general public who are the potential victims, and finally, to what extent should States make available public funds for compensation? Clearly the public exposed must be ensured of reasonable protection in the face of unknown dangers, both on legal and on psychological grounds; on the other hand, the development of the nuclear industry must not be hindered by an intolerable burden of liability.

These problems, complex enough on a national basis, when examined internationally become much more complicated. There are many reasons for this, among them the multiplicity and variety of legal rules and traditions in different countries, widely varying economic and industrial circumstances, the differing rôles of public authorities as owners of power utilities or suppliers of electricity, and the degree of Government subsidy in the nuclear industry. There are also often substantial differences in public attitudes to nuclear developments.

Moreover, the circumstances of a nuclear incident can be infinitely complicated: for example, a reactor located and operated in one country, designed or equipped by a supplier from another country, may cause damage to persons and property in yet other countries.

A balance of all the interests involved is not easy to attain. The OEEC Convention on Third Party Liability, which had been signed by the deadline date of October 31, 1960, by 16 countries[3], provides a basic solution. It should be emphasized that signature by the 16 countries is only the first stage; the Convention will effectively come into force when it has been ratified by at least five of the signatory countries, and then only between those five countries. Thereafter, it will come into force for the other signatory countries as and when they have ratified it. Although normally ratification is a lengthy procedure, there is some hope that in this case early ratification will be forthcoming, since most European countries are well advanced in the preparation of domestic legislation and in one or two cases legislation has been deliberately held up in order to incorporate the provisions of the OEEC Convention as finally agreed upon.

In the three countries where nuclear liability legislation has already been enacted, namely the United Kingdom, Western Germany and Switzerland, the provisions of the Convention were taken into account at the time of drafting, although minor amendments will be necessary; for example in the United Kingdom, the Nuclear Installations (Licensing and Insurance) Act, 1959, will have to be modified to take account of the OEEC rules on liability for nuclear incidents arising in the course of transport of nuclear substances to and from a site.

The OEEC Convention is not a universal panacea; it is in many respects the result of compromise born of lengthy and difficult negotiations. Nevertheless, the changes relating to liability which it introduces are far-reaching and are inspired by an assessment of the probable inadequacy of traditional legal rules in the event of a nuclear incident. The law is here taking the lead in a pioneering experiment in the absence of which the nuclear industry would undoubtedly be prevented from developing.

Atomic energy has evolved from military origins through direct Government or public activity or through public financing and only in the past few years has private industry in Western Europe begun to play its full part in the development of the new industry. But it is not only the rôle of private industry as utility operators but also as suppliers which brought the nuclear liability problem to a head: even under State ownership of electricity undertakings, reliance is placed to no small extent upon private undertakings, both foreign and domestic, for design, construction and supply.

Without a satisfactory solution to the liability problem private industry has shown a circumspect hesitation to commit itself fully in the domestic market. Moreover, it is no secret that the conclusion of a number of contracts for the construction of nuclear power stations of foreign origin in Europe has hinged upon successful resolution of the liability problem. In one case, indeed, it was specifically provided that no fuel would be delivered for the reactor supplied unless the liability provisions in the contract were agreed upon the basis of the OEEC Convention.

One of the principles which has been adopted in the Convention—namely the limitation of liability of the operator—necessarily raises a problem which cannot be said to have been satisfactorily settled. This is the problem of State indemnification. There is wide agreement on the need to channel all liability onto the operator and to limit the operator's liability in amount. It is better for victims to have recourse to a limited fund guaranteed by insurance than unlimited claims on the operator's resources, which are likely to be worth far less than a special financial security such as insurance. From the standpoint of the operator there seems to be elementary equity in counterbalancing his being absolutely and exclusively liable by placing a limit on what he or his financial guarantors should be called upon to pay. But what happens if the claims exceed the limited amount of the operator's liability?

Under the OEEC Convention the liability of the operator is limited to $15 million, but over and above this each State is free to provide compensation as it deems necessary. During the negotiations on the Convention it proved difficult for Governments to agree in advance on a broad international basis to assume financial responsibility for any compensation above the operator's liability.

The problem of State intervention sometimes seems more apparent than real. Experience during the enactment of the three European laws already mentioned shows that it is politically impossible for any Government in Western Europe to place before its Parliament a law under which the liability of an operator of a nuclear installation is limited in amount, unless additional measures are envisaged if the amount of compensation claimed should exceed the operator's liability.

Under the German Act there is State intervention up to DM500 million per nuclear incident; under the Swiss Act, the Government is bound to take the necessary steps to provide compensation if the Sw. Fr. 30 million (the minimum required to be held as security by the operator for each nuclear incident) is not sufficient to meet claims. Under the U.K. Act, the Minister of Power is obliged to notify Parliament when the

1. The author is expressing his own views which do not necessarily coincide with those of the Agency.
2. The word "incident" is now used as a term of art in connection with nuclear liability instead of the word "accident" which has a special meaning in conventional insurance. "Incident" covers not only a single accident or occurrence but also a series of occurrences having the same origin: i.e., a continuous release of radioactivity.
3. Switzerland, Denmark, Luxembourg, The Netherlands, United Kingdom, Norway, Western Germany, Sweden, Belgium, Austria, Portugal, Greece, Spain, Italy, Turkey and France. An outline of the provisions of the Convention was given in the September issue of *Nuclear Engineering*.

financial security (£5 million per nuclear site during the validity of each operating licence) which the operator has to maintain has been substantially reduced as a consequence of a nuclear incident, and it is for Parliament to decide what steps should be taken if claims finally exceed the amount of compensation available.

None the less there is some uneasiness that anything less than an obligation on the State in advance to pay excess compensation is unsatisfactory. But the difficulties involved in Governments expressly assuming this responsibility in an international convention should not be underestimated. Some Governments traditionally hesitate to commit themselves in advance for budgetary (as in the United Kingdom) and other reasons to any compensation for large-scale disasters. Some Governments are all too frequently faced with the unhappy consequences of natural disasters, especially flooding, but here they do not assume unlimited responsibility in advance; they grant compensation as a matter of course and because politically and socially there is no alternative. However, the risk to which the public is exposed from nuclear installations, unlike risks from natural disasters, is man-made and the result of deliberate choice. Once the liability of the nuclear industry has been limited in amount public pressure for State intervention is likely to increase. Whether Governments assume full responsibility in advance or whether they assume responsibility conditional upon the occurrence of a major disaster and tailor the intervention to meet each case as it arises, it is certainly not possible for States to refuse any responsibility.

As has been said already, the new legal régime based on the OEEC Convention is in some ways experimental, and future developments in this field may depend to a considerable extent upon the rôle of the insurance industry. Hitherto Governments and public authorities, which have for the most part operated Europe's nuclear installations, have not taken out insurance coverage to meet their liability or part of it. But the emerging rôle of private industry and the impact of international projects is highlighting the importance of insurance.

The effort demanded of the insurers is considerable. They are asked, even under the limitation of liability which has been accepted, to insure amounts that by the standards of most conventional industries are extremely high, and they are asked to do this with little or no actuarial or statistical basis for assessing risks or calculating premiums. Insurers have already set about meeting the challenge by pooling their resources on a national basis and effecting close collaboration among national pools through reinsurance. They have begun to standardize policies and to develop criteria for evaluating the risks.

They are already providing insurance for national nuclear installations (e.g. at Ispra in Italy and Geesthacht in Western Germany) and for international projects (e.g. the ENEA Halden reactor). They are also helping their American colleagues by reinsurance. More and more they will be called upon to insure other installations.

None the less, a gap exists between the limit of insurance obtainable and the protection which public attitudes seem to demand beyond the OEEC limitation, and this gap can only be filled by State intervention. The insurance industry will undoubtedly reduce this gap in the coming years. With favourable experience and a rapid development in atomic energy, lowering by Governments of the protection required may coincide with increased capacity on the part of insurers to provide coverage; it may even be that the gap will disappear completely.

Whilst it is impossible for Governments to ignore the problem of State intervention entirely, certain international arrangements—notably the Euratom-United States Agreement—positively require Governments to agree internationally to some form of State intervention. Thus the six Governments of the Euratom countries are well advanced in the drafting of an agreement on State intervention to supplement the OEEC Convention. Moreover, it is expected that this agreement, although primarily intended to provide a solution to the nuclear liability problem satisfactory to the United States Government under their Agreement for Co-operation with Euratom, is likely to be open to the acceptance of other countries not members of Euratom. There is, in addition, the genuine belief on the part of some Governments, particularly the French Government, that obligatory State intervention in advance is of paramount importance.

All these considerations may in the end provide a sufficient stimulus to the attainment of widespread international acceptance of State intervention in advance and thus effectively round off the solution to the problem of liability for nuclear risks.

State Intervention Proposals

THE discussions which have been initiated by Euratom to define consistent measures for State intervention in the event of a nuclear incident have now reached an advanced stage. It should be emphasized at the outset that this is not a measure that can be imposed by Euratom on its member countries nor, indeed, is it intended that acceptance of the proposals should be confined to them. Rather in this context has Euratom, because of its more pressing requirements for establishing a uniform policy within the Messina countries, taken upon itself the task of producing a scheme which would be acceptable to as many countries in Europe as possible.

Government organizations, industry, the insurance market both within and outside the Euratom countries have been consulted and it is hoped that by the end of the year a firm plan will have been produced. This will then go to the European Council of Ministers and assuming that it is approved by the Council will almost certainly result in the scheme's acceptance by the Euratom countries, and be followed by suitable national legislation. At the same time, it is hoped that many outside countries will accept the principles and introduce legislation within their own boundaries making similar provisos and permitting the establishment of a federation of countries all contributing to and forming part of the one system.

The proposed scheme is in no way an alteration of the OEEC Convention but an extension to it. Operators of installations will be required to accept the responsibility of any nuclear incident up to the maximum figure of $5-$15 million (according to their national legislation). For incidents which involve third party damage in excess of the operator's liability, the government of the State in which the installation is located will bear specific responsibility up to a total of $70 million; i.e., for the next $55-$65 million depending upon the initial coverage. If the total claims exceed $70 million then a further $40-$50 million (the exact amount is not yet decided) would be provided by an international pool to which all members of the federation would contribute. This would be a government contribution and the method of calculating a given government's proportional contribution has still to be worked out. A number of alternatives are open based on the total national income, the extent of the nuclear installations, etc. Clearly the more members there are of the federation the less is the liability of each government for any incident.

The proposals will not contain recommendations for covering incidents in excess of the maximum figure as it is considered to be the maximum credible damage for which any prior legislation needs be made. As with the OEEC Convention a five-year trial period is contemplated after which reconsideration could be given to the scheme. It is not felt that this will cause reactor manufacturers or owners to doubt the continuity of the ceiling government protection, but will permit modifications in the light of expanding knowledge. One of the most difficult aspects of the proposals is the status of military installations and whether these should be covered in exactly the same manner. There is clearly a great deal of room for controversy on this particular point and no firm decision has yet been taken as to what recommendations should be made.

Industry in the Netherlands

By Dr. W. REYSEGER

(Managing Director, Reactor Centrum Nederland.)

THERE are a number of organizations concerned with the development of nuclear energy in the Netherlands. There is a Nuclear Energy Committee in this country, which is responsible for the co-ordination of inter-departmental contact and relations, and whose purpose is to:

(a) Advise the Government on matters regarding the development of the peaceful application of nuclear energy;

(b) Design directives for the representatives of the Government on the Board of the Reactor Centrum Nederland.

Research and development of atomic energy is not in the hands of the Government as, for example, in England, the United States and France, nor is it in the hands of industrial organizations or electricity companies. We have endeavoured to combine all the interested parties together into *one* organization in the form of a Foundation. To this end, the Reactor Centrum Nederland was founded in 1955, with representatives of the respective organizations included. These were: Industry, Electricity Companies, the State and Science.

At the start, each of these four groups invested a quarter share in R.C.N. The main purpose was to build a Centre around a High Flux Reactor which was chosen especially for the carrying out of material tests for industry and for neutron-physics research. More capital was required as further investments became necessary and the State contributed towards this. The strongest argument in favour of this contribution on the part of the State was that the erection and outfitting of a large scientific Centre should be the result of a concentrated national effort to which the State itself makes the largest contribution.

About 50 enterprises participate in R.C.N., which can be grouped as follows: producers of large thermal power installations, shipowners, chemical industries, electrotechnical industries, metallurgical industries, rayon factories and other enterprises. They are connected to R.C.N. by the Commissie Bedrijfsleven (inter-industries representatives' committee) whose Chairman and Secretary are members of the Board of R.C.N.

In evaluating the part played by R.C.N. in the development of nuclear industry in the Netherlands, it would, perhaps, be advisable and helpful, if some details of R.C.N.'s working programme are mentioned. This programme can be divided into three sections: the scientific programme, the so-called radiation programme and the industrial programme.

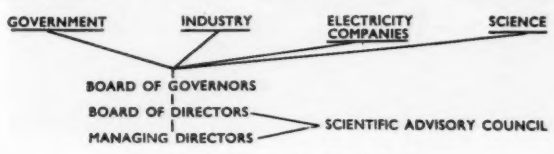
So far as the scope of this article is concerned, the last mentioned is the most interesting. The industrial programme is based on the study of the problems and difficulties around a small reactor with a high specific power. This programme comprises a great many projects and aims to promote the greatest possible stimulation to the technological advance of Dutch industry. These projects are, in so far as they are of a nuclear character, carried out at the Research Centre of R.C.N. at Petten. Amongst these are the execution of a critical experiment and the development of ceramic fuel. There are also some projects of an indirect nuclear character such as the development of pressure vessels and heat exchangers. We hope that these will be carried out by Dutch industry, whereby R.C.N. acts, in a manner of speaking, as the catalyst.

Another R.C.N. venture which underlines the relationship between R.C.N. and the Electricity Companies, is the internationally well-known suspension reactor project being carried out by the K.E.M.A., Arnhem, by order of R.C.N. Since 1960, Euratom has also participated in this project, to which many technological problems are attached, and it goes without saying that Dutch industry is also working on the subject. A further project that opens the door to new possibilities, in our opinion, is the separation of the U^{235} and U^{238} isotopes by means of the ultra-centrifuge. The present method of separating U-isotopes is not economical and we consider that a concentrated research into the possibilities offered by the ultra-centrifuge method would be advantageous.

Albeit indirectly, R.C.N. has attempted to involve Dutch industry in nuclear projects. There is, for example, the V.I.O.P. (Liaison Office International Research Projects), an office attached to R.C.N., of which the purpose is to arrange contacts between, amongst others, Dutch industry and foreign nuclear projects. From this fairly detailed summary of the structure and objectives of R.C.N., an idea of the new relationship to industry in its development can be seen.

Industrial Efforts

In 1959 an industrial group, the N.V. Neratoom, was formed in the Netherlands. N.V. Neratoom is a combination of enterprises which is capable of executing large and extensive orders in the field of nuclear energy. The following concerns are involved: N.V. de Schelde, Rotterdamsche Droogdok Mij N.V., N.V. Philips' Glolilampenfabrieken, Werkspoor N.V., Koninklijke Machinefabriek Gebr. Stork and Co. N.V. and N.V. Machinefabriek "Berad" v/h



Scientific liaison in the Netherlands.

Backer en Rueb. This Group has been commissioned to build a steam generator for the SENN reactor project in Italy, amongst other things.

It is difficult to give a general assessment of the expertise at present available in industrial organizations in the fields of specific reactor construction and essential equipment manufacture. There are a few major Dutch industries holding a position of world importance in certain fields, as for example, that of instrumentation. Other industries have entered into licensing agreements with major international concerns with regard to the construction of units of reactor plants. Dutch industry is concerned in deliveries for various nuclear energy projects in the Netherlands, e.g., the construction of R.C.N.'s Research Centre at Petten; preparations for the construction of a reactor for the Institute for the Application of Nuclear Energy to Agriculture at Wageningen; the construction of the Reactor Institute at Delft, an inter-university concern, where, amongst other things, a swimming-pool reactor is being built; the suspension reactor project in Arnhem and the ultra-centrifugal project in Amsterdam. Dutch industry is also taking part in several foreign and international projects, e.g., the SENN project in Italy (as mentioned above), the Halden project in Norway; the Dragon project in England and the Eurochemic project at Mol (Belgium).

Investment

It is, of course, obvious that it is not possible to name a total of investments which Dutch industry has made in the field of nuclear energy research and development. This research, for many concerns, forms a part of other research work. The only publicly known amounts concern the participation of Dutch enterprises in R.C.N. These enterprises have, to date, contributed a total of some fls.11,000,000 (£1,100,000 sterling) in investments and exploitation in R.C.N.

I should like to point out the following, concerning the tendency of Dutch nuclear development in the Netherlands in so far as it concerns the part which the Netherlands, as a nation, will possibly play in nuclear production. One wonders if home development is preferable to licensed construction or if perhaps an attempt should be made to combine the two alternatives in some way. In my opinion, and it is one which is shared by very many industrialists, sound development of Dutch nuclear industry should, in principle, tend toward home development, thereby gaining a certain status for the Netherlands in the world market and at the same time offering openings for international collaboration. R.C.N. can serve here as a communal research centre and institute for development.

One of the most interesting features of the Petten nuclear research centre is the high-flux research reactor supplied by Allis-Chalmers.

This very problem is at the moment under discussion and study by a Committee for Nuclear Industrial Development, which body was installed on April 26 this year, by the Minister for Economic Affairs. This Committee will report on the possibilities arising from the use of nuclear energy so far as Dutch Industry is concerned. The Committee's recommendation will be particularly concerned in the following:

(a) The sectors of nuclear energy production areas which offer the best possibilities for industry.

(b) The trends towards which industrial research and development in the field of nuclear energy should move and the extent of this research and development.

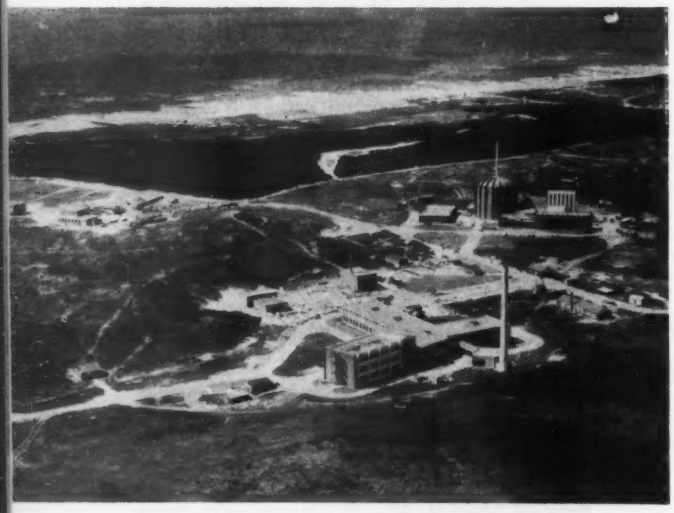
(c) Organization and planning of industrial research and production development in the field of nuclear energy.

Industrialists of major importance are incorporated in this Committee.

The value of international collaboration with other industries in Europe and the United States should not be overlooked, while aiming at a powerful and national nuclear industry. This certainly applies in the case of collaboration in the field of development of reactor components, whereby the position of the collaborating organizations' licences has to be clearly defined.

I hope that it will by now be clear that even a small nation such as the Netherlands, which, relatively speaking, entered the field of nuclear energy rather later than most, is actively engaged in this field. Furthermore, there is a definite increase in these activities.

Nuclear development demands insight and courage, not only for development along the more conventional lines but also for the scouting of unknown prospects. The Netherlands industry, backed up by the high standard of scientific research in this country and by the national nuclear organization will accept this challenge. Personally, I have the utmost confidence in the outcome of our struggle and in the rôle played by our industry in the nuclear world both now and in the future.



An aerial view of the R.C.N. Establishment at Petten.

Nuclear Industry in Belgium

by Dr. J. VAN DER SPEK
(Managing Director, BelgoNucleaire)

NUCLEAR energy has been developed, in the principal countries, according to prevailing economic and technical factors. These include the capacities of the manufacturing, metallurgical and chemical industries, the importance of export sales, the cost of conventional energy, the reserves of fuel and water-power, the availability of enriched uranium and heavy water, etc. In Belgium the situation is especially characterized by a considerable development in companies able to participate in the construction of reactors and other nuclear installations (reprocessing plant, factories for the fabrication of fuel elements and production of nuclear metals), an export market absorbing 40% of our total production, a relatively high cost of conventional power because of the difficulty of exploiting our coal mines, the production capacity of which is limited, an economy in constant expansion and finally the possibility of obtaining enriched uranium through our bilateral agreements with the U.S.A.

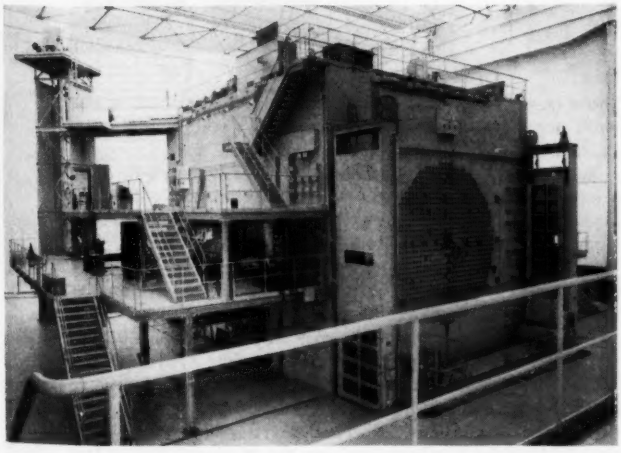
Therefore, it seems that the basic principles of the Belgian nuclear policy can be expressed as follows:—

(1) Our country must become actively engaged in the construction of nuclear reactors and their complementary installations, both for its own needs and for those of its traditional foreign customers.
(2) Our country is not greatly limited in the choice of reactor types and fuel cycles.

Official Bodies

Concerned with the implementation of this overall policy are the official Belgian nuclear organizations comprising the Commissariat à l'Energie Atomique (Commissaire: M. Jacques Errera), the Centre d'Etude de l'Enèrgie Nucléaire in Mol (Chairman: Comte Marc de Hemptinne) and the Institut Interuniversitaire des Sciences Nucléaires (Chairman: M. J. Willems). It is mainly with the first two of these that the Belgian industry is in contact, contacts which are, in fact, most cordial and productive.

Belgium's first reactor, BR-1.



The Commissaire à l'Energie Atomique is, in the matter of international nuclear relations, the chief counsellor of the Belgian Ministry for Foreign Affairs. On the other hand, he deals with the co-ordination, orientation and implementation of Belgian nuclear policy. Within the scope of his activities, he gives a strong stimulus to the development of our industry and contributes efficiently to the solution of many critical problems.

The Centre d'Etude de l'Energie Nucléaire has created, in a few years, a remarkable complex of nuclear laboratories including three reactors and has set up those principal staff divisions found in any nuclear institute, viz., physics, metallurgy, technology, electronics, etc. Belgian industry has had the opportunity of acquiring valuable experience by supplying equipment as well as by the research work it has carried out at the C.E.N. It will benefit technically even more in the future, as the Centre d'Etude de l'Energie Nucléaire is intent on placing contracts for complete nuclear plants with home concerns.

Confronted on the one hand with the necessity for encouraging nuclear energy development in Belgium and on the other for maintaining their financial balance when pressed by falling sales tariffs and rises in the cost price of certain items, the Belgian electricity-producing companies have adopted a cautious but realistic attitude towards atomic energy problems.

They have played an important part in financing the BR-3 reactor at Mol (11.5 MW(e)PWR), half the cost of which is provided by the sectors of the electricity suppliers and half by the manufacturing industries, and have just established, together with Electricité de France, the Ardenne nuclear power station project for an output of 240 MW(e). They maintain close contacts with the national nuclear industry, but do not entirely preclude the possibility of an appeal to foreign suppliers.

On the other side, the companies taking part in the construction of reactors and their ancillaries have been well organized and equipped to carry out their tasks. The Société Générale Métallurgique de Hoboken has erected and operates a uranium refining plant, producing metal, oxides and salts of nuclear purity. The Métallurgie et Mécanique Nucléaires has facilities for the fabrication of fuel elements and complete cores. About 50 industrial companies have founded (a little like the English nuclear groups) the BelgoNucléaire, a common office of industrial nuclear studies, which designs and organizes the

construction of complete nuclear projects (research and power reactors, etc.).

The Ateliers de Constructions Electriques de Charleroi (A.C.E.C.) has acquired a Westinghouse licence, shared by Cockerill-Ougrée and Métallurgie et Mécanique Nucléaires, for the construction of nuclear reactors. Belgian private industry takes part through the Société Belge de Chimie Nucléaire in the international organization, Eurochemic, which is building a reprocessing plant for irradiated fuels near Mol.

For their part, the electricity-producing companies have founded the Bureau d'Etudes Nucléaires which occupies the position of nuclear consulting engineer for the company responsible for the construction of the plant.

To conclude, mention should be made that the general interests of nuclear concerns are being taken care of by a private organization, the Groupement Professionnel de l'Industrie Nucléaire.

Belgium, which is traditionally a manufacturing and transforming country, is in possession of industries able, with a few exceptions, to produce most of the constituent pieces and materials of reactors: nuclear fuels, control rods and their drive mechanisms, heavy boilers, instrumentation and electronics.

The smallness of its territory and the industrial limits which derive from it, perhaps also the results of an initial setback due to the war, soon led Belgium to search for collaboration in the international field. We have noted, before, the important licence acquired from Westinghouse Mécanique Nucléaires. On its side Belgo-Nucléaire, having Mécanique Nucléaires. On its side BelgoNéaire, having propounded a long-term policy based on the study and exploitation of the complete plutonium cycle, has concluded a contract for technical co-operation with the groups Atomic Power Development Associates (APDA) and Power Reactor Development Company (PRDC), which have built, near Detroit, Mich., U.S.A., the Enrico Fermi power plant, equipped with a 100 MW(e) fast breeder reactor. As a result of this contract, six Belgian engineers have participated for five years in the Enrico Fermi project.

On the same principles, BelgoNucléaire, in association with the Centre d'Etude de l'Energie Nucléaire, is studying the use of plutonium in research and power reactors, which includes the fabrication of uranium enriched with plutonium. For this purpose, it receives the benefit of an important contract from Euratom.

Such is, in brief, the present situation. We must now consider what the future will bring us and what the wishes of nuclear industrialists are, especially vis-à-vis the large international organizations and the progressive integration of Europe. Everybody who is studying the major problems of nuclear energy is immediately struck by the significance of the investments that the nuclear manufacturing industry has to accept. He who makes the investments also makes the choice of the technical solutions and the long-term programmes.

There seem, therefore, two questions which demand the closest attention of the responsible authorities (and of which they are certainly conscious). To enable industry to equip itself properly it requires that the technical solutions towards which we are moving (for example, the selection of classes of reactors and fuel cycles) be defined as accurately as possible, and equally that some minimum programmes of nuclear construction be settled.

Consequently, we should like to end by hoping that two essential factors of success be actively pursued in Belgium and in the countries of Euratom: co-ordination for the present; long-term programmes for the future.

The Italian Nuclear Programme

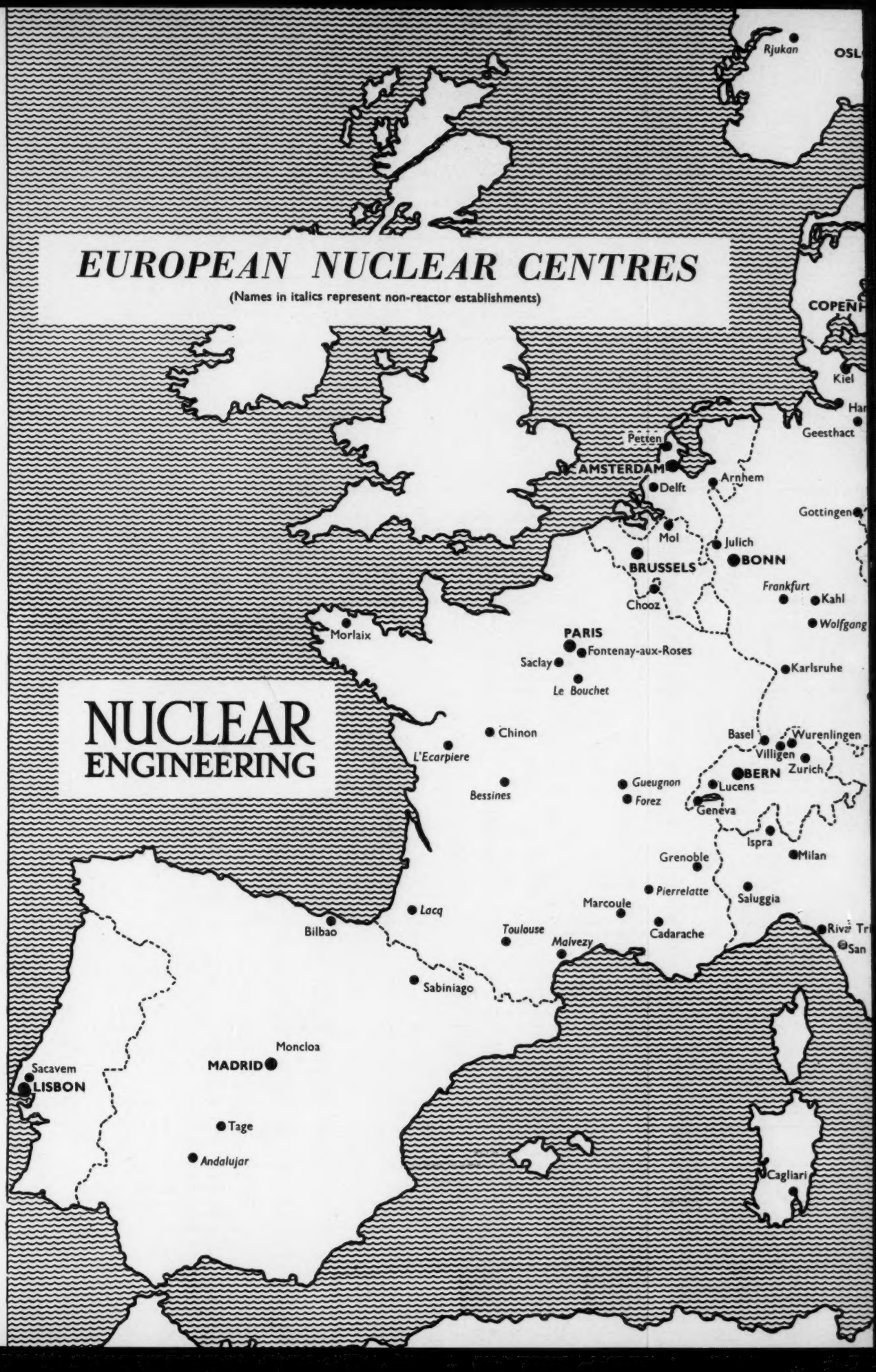
by **DR. ING. FRANCO CASTELLI**
(Member of the Steering Committee, Forum Italiano dell'Energia Nucleare)

ITALY'S programme for the peaceful uses of atomic energy is one of the largest and most significant among those of the European countries. Three nuclear power plants, totalling over 500 MW(e), several research centres equipped with different reactors, bear witness to the deep Italian interest in the peaceful uses of nuclear energy.

The first positive manifestation of the interest in the nuclear field dates back, in Italy, to 1946, namely to the immediate after-war period when, through the initiative of some predominantly private industrial companies, and a group of physicists, the "Centro Informazioni Studi ed Esperienze" (CISE) was created; thanks to it Italy was able to take the first steps in this important new sector of technique, notwithstanding the serious difficulties of the time. The activities of CISE progressed and, starting from nothing, an organic complex of laboratories was set up and a team of highly qualified research men formed, whose work represented for many years Italy's sole contribution in the domain of applied nuclear research.

Successively, the base of the CISE was widened through a larger participation of public and Government controlled bodies. Thus, CISE is now characterized by the participation, on equal terms, in its financing of a group of private companies (Edison, Falck, FIAT, Montecatini, Pirelli, SADE) and a group of Government controlled companies (IRI, Cogne, Milan Municipality).

The Comitato Nazionale per le Ricerche Nucleari (CNRN) was then founded in 1952 as the Government's technical organization with tasks limited principally to fundamental and applied research in the nuclear field. This National Committee for Nuclear Research has been transformed by a recent law into the National Committee


EUROPEAN NUCLEAR CENTRES
(Names in italics represent non-reactor establishments)
NUCLEAR ENGINEERING
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Delft
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BONN
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Kahl
Chooz
Wolfgang
Morlaix
PARIS
Fontenay-aux-Roses
Saclay
Karlsruhe
Le Bouchet
Chinon
Basel
Wurenlingen
Villigen
L'Ecarpiere
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BERN
Gueugnon
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Forez
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A second plant is
Heavy water plant

AUSTRIA

Research Reactors

Owner	Location	Name	Type	Power (MWt)	Function	Critical	N.E. Ref.
n Research Centre ..	Seibersdorf	ASTRA ..	Tank (AMF)	5/12 ..	Research; materials testing ..	1960	Nov. 1960. 491
y of Education	Vienna..		Pool .. (TRIGA II)	10/30 kW	Research and training	1960	March 1960. 101 (typ.)

stria has no concrete power programme. The Osterreichische Elektrizitatswirtschaft A.G. has a project for a 100–150 MWe power reactor to be built between 1966–8.

BELGIUM

Research Reactors

Owner	Location	Name	Type	Power (MWt)	Function	Critical	N.E. Ref.
.. ..	Mol	BR–1	Graphite-air	4	Physical research, radioisotopes ..	1956	Aug. 1960. 361
.. ..	Mol	BR–2	H_2O and Be*	25/50 ..	Materials testing	1960/61	Oct. 1958. 434
.. ..	Mol	BR–02 ..	Pool ..	100 W ..	Zero-energy facility for BR2 ..	1960	Aug. 1960. 342

BR–2 is the " hour-glass " core reactor.

Power Reactors

Owner	Location	Name	Type	Power (MWe)	Main supplier	Critical	N.E. Ref.
.. ..	Mol	BR–3	PWR ..	11.5 ..	Westinghouse	1960	Aug. 1960 337

ere is a joint Belgian–French power project for a 242 MWe PWR reactor to be located in the loop of the Chooz, in the Ardennes district. (*N.E.* Sept. 1960. 381).
e Eurochemic fuel processing unit is also located at Mol, adjacent to the C.E.N. establishment.

DENMARK

Research Reactors

Owner	Location	Name	Type	Power (MWt)	Function	Critical	N.E. Ref.
AEC	Risø	DR–1	Homogeneous (A.l.)	0.5 ..	Physical research	1957	March 1960. 124
AEC	Risø	DR–2	Tank (F.-W.)	5	Neutron experiments, isotopes ..	1958	June 1960. 280
AEC	Risø	DR–3	Pluto (H.W.)	10.. ..	Research	1960	April 1958. 150

nmark has as yet no power reactor programme. DANATOM have, however, published a study of a 175 MW gas-cooled reactor (BETA). (*N.E.* June 1960. 264).

FRANCE

Research Reactors

Owner	Location	Name	Type	Power (MWt)	Function	Critical	N.E. Ref.
.. ..	Fontenay-aux-Roses ..	EL–1	D_2O ..	0.15 ..	Basic research	1948	
.. ..	Saclay	EL–2	D_2O–gas ..	2.5 ..	Research, materials testing ..	1952	
.. ..	Saclay	Aquilon ..	D_2O ..	—	Lattice studies	1956	
.. ..	Saclay	EL–3	D_2O–D_2O ..	15.. ..	Research, materials testing ..	1957	March 1958. 115
.. ..	Grenoble	Melusine ..	Pool ..	1.2 ..	Research and training	1958	Jan. 1960. 36
.. ..	Saclay	Proserpine ..	Homogeneous Pu.	—	Plutonium studies	1958	
.. ..	Fontenay-aux-Roses ..	Triton ..	Pool ..	1.2 ..	Protection studies	1959	
.. ..	Fontenay-aux-Roses ..	Minerve ..	Pool ..	—	Purity control	1959	
.. ..	Saclay	Alize	Pool ..	—	Lattice studies	1959	
.. ..	Saclay	Peg	Pool ..	—	Research for Pegase	1959	
.. ..	Cadarache	Pegase ..	Pool ..	30.. ..	Fuel element testing	1961	
.. ..	Cadarache	Rapsodie ..	Breeder ..	10.. ..	Breeder studies, rapid neutron irradiation.	1963	
.. ..	Cadarache	Sous-Marin ..	—	—	Propulsion experiments	—	

Power Reactors

Owner	Location	Name	Type	Power (MWe)	Main supplier	Critical	N.E. Ref.
.. ..	Marcoule	G.1	Air/graphite	5 ..	C.E.A.	1956	June 1958. 258
.. ..	Marcoule	G.2	Gas/graphite	28 ..	C.E.A.	1958	Dec. 1959. 435
.. ..	Marcoule	G.3	Gas/graphite	28 ..	C.E.A.	1959	
.. ..	Chinon	EDF.1	Gas/graphite	60 ..	E.D.F.	1961	Feb. 1959. 67
.. ..	Chinon	EDF.2	Gas/graphite	170 ..	E.D.F.	1962	Nov. 1960. 491
.. ..	Chinon	EDF.3	Gas/graphite	300 ..	E.D.F.	1964	Aug. 1960. 335
.. ..	Chinon	EDF.4	Gas/graphite	400 ..	E.D.F.	1965	May 1960. 194
.. ..	near Morlaix	EL.4	D_2O-gas ..	80 ..	C.E.A.	—	

nce has ore processing plants at Bessines, L'Ecarpiere, Gueugnon, Forez, Le Bouchet, and Malvezy.
adiated fuel reprocessing is dealt with at Marcoule.
econd plant is to be built at La Hague, near Cherbourg. At Pierrelatte, isotope separation is carried out.
avy water plants are located at Lacq and Toulouse.

GERMANY

Research Reactors

Owner	Location	Name	Type	Power (MWt)	
Bavaria	Munich	FRM	Pool	1–2	Resea
GKSS	Hamburg	FRH	Pool	5	Resea
Hessen	Frankfurt	FRF	Homogeneous boiling	50 kW	Resea
Berlin	Berlin	FRB	Homogeneous boiling	50 kW	Resea
Rhine Septentrional Westphalia	Julich	FRB	Pool (Merlin)	5	Resea
Kernreaktor Bau und Betriebs GmbH	Karlsruhe	FR2	D_2O–D_2O	12	Resea
Rhine Septentrional Westphalia	ulich		DIDO	10	Mater

Power Reactors

Owner	Location	Name	Type	Power (MWe)	
RWE	Kahl	—	BWR	15	IGE-A
AVR	NRWCR Julich	—	High temp.	15	BBC–
—	—	—	D_2O	100	Siem
—	—	SNDR.1	D_2O	50	Siem
SKW	—	—	AGR	100	Babc
SKW	—	—	BWR+super-heater	100	IGE–A
AKS			OMR	150	Intern

Heavy water plant at Frankfurt.
Fuel preparation plants at Wolfgang (*N.E.* July 1960. 320) and Augsburg.

ITALY

Research Reactors

Owner	Location	Name	Type	Power (MWt)	
University of Palermo	Palermo		AGN–201		
Institute of Chemistry	Cagliari			—	Resea
C.N.R.N.	Ispra	Ispra I	CP–5	5	Resea
SORIN	Saluggia	Avogadro–R.S.–1	Pool	1/5	Resea
Enrico Fermi Centre	Milan		Homogeneous	50 kW	Resea
C.N.R.N.	Rome		Pool TRIGA II	30/100 kW	Resea
CAMEN	Livorno		Pool	5	Resea

Power Reactors

Owner	Location	Name	Type	Power (MWe)	
SIMEA	Latina	Latina	Gas/graphite	200	TNPG
SENN	Garigliano	Garigliano	BWR	150/230	IGE
SELNI	Trino (Northern Italy)	Trino	PWR	135	West

THE NETHERLANDS

Research Reactors

Owner	Location	Name	Type	Power (MWt)	
R.C.N.	Petten	HFR	ORR modified	20	Resea
Netherlands Universities	Delft	HOR	Pool	100 kW	Resea
R.C.N. K.E.M.A.	Arnhem	Suspop	Homogeneous	0.25	Expe
R.C.N.	Petten	LFR	Jason	10 kW	

There is, as yet, no concrete project for a power reactor.

NORWAY

Research Reactors

Owner	Location	Name	Type	Power (MWt)	
I.F.A.	Kjeller	JEEP 1	D_2O	0.5	Rese
I.F.A.	Kjeller	NORA	D_2O	—	Criti
I.F.A.	Kjeller	JEEP 2	D_2O	—	Expe

Power Reactors

Owner	Location	Name	Type	Power (MWt)	
I.F.A.*	Halden	Halden	Boiling D_2O	5–20	I.F.A

* The reactor is now operated as a joint ENEA undertaking. It has no electrical output.
Norway has a heavy water plant at Rjokan.

ower (MWt)	Function	Critical	N.E. Ref.
..	Research, isotopes	1958	Oct. 1960. 428
..	Research, marine propulsion ..	1958	Sept. 1960. 418
W ..	Research, isotopes	1958	
W ..	Research, chemistry of radionuclides	1958	
..	Research, materials testing, isotopes	1960	
..	Research, fuel elements, isotopes ..		
..	Materials testing, isotopes	1961	

Owner	Location
J.E.N.	Lisbon (Sacavem) ..

ower (MWe)	Main supplier	Critical	N.E. Ref.
..	IGE-AEG	1960	
..	BBC–Krupp	1962	Nov. 1960. 491
..	Siemens Schuckertwerke	—	
..	Siemens Schuckertwerke	—	
..	Babcock and Wilcox	—	
..	IGE–AEG	—	
..	Interatom	—	

Owner	Location
C.P.I.N.	—

Owner	Location
J.E.N.	Moncloa .. ..

ower (MWt)	Function	Critical	N.E. Ref.
—		1960	
	Research and training	1958	
..	Research, training, isotopes ..	1959	
..	Research	1959	Dec. 1959. 467
W ..	Research and training	1959	
00 kW	Research and training	1960	
..	Research propulsion	Project	Feb. 1960. 82

Owner	Location
CENUSA	Madrid .. ..
NUCLENOR	Burgos .. ..
CENUSA	Madrid .. ..

Fuel processing plant at Andalujar.

ower (MWe)	Main supplier	Critical	N.E. Ref.
..	TNPG	1962	Oct. 1959. 329
230 ..	IGE	1963	May 1959. 200
..	Westinghouse	1962–3	

Owner	Location
AB Atomenergi	Stockholm .. ..
AB Atomenergi	Studsvik .. ..
AB Atomenergi	Studsvik .. ..
AB Atomenergi	Studsvik .. ..

NDS

Power (MWt)	Function	Critical	N.E. Ref.
..	Research, materials testing ..	1960	
kW ..	Research and training	1957	Aug. 1957. 327
..	Experimental research		
kW ..		1960	Nov. 1960. 491

Owner	Location
AB Atomenergi	Agesta .. ..
State Power Board	Marviken .. ..
A.K.K.	Simpevarp .. .. (East Coast)

There are processing plants at Kvantorp, Studsvik a

Power (MWt)	Function	Critical	N.E. Ref.
..	Research, isotopes	1951	Feb. 1959. 64
—	Criticality experiments	1960	
—	Experimental physics, isotopes ..	Project	

Owner	Location
Reaktor A.G.	Würenlingen .. ..
University of Geneva	Geneva .. ..
University of Basle	Basle .. .. ..
Reaktor A.G.	Würenlingen ..

Power (MWt)	Main supplier	Critical	N.E. Ref.
20 ..	I.F.A.	1959	March 1959. 106

Owner	Location
ETH Zurich	Zurich .. .. ..

PORTUGAL

Research Reactors

Owner	Location	Name	Type	Power (MWt)	Function	Critical	N.E. Ref.
J.E.N.	Lisbon (Sacavem)		Pool	1		1960	

Power Reactors

Owner	Location	Name	Type	Power (MWe)	Main supplier	Critical	N.E. Ref.
C.P.I.N.	—	—	—	30	—	1966	—

SPAIN

Research Reactors

Owner	Location	Name	Type	Power (MWt)	Function	Critical	N.E. Ref.
J.E.N.	Moncloa	JEN–1	Pool	3	Research	1958	

Power Reactors

Owner	Location	Name	Type	Power (MWe)	Main supplier	Critical	N.E. Ref.
CENUSA	Madrid	—	—	250	—	1968	
NUCLENOR	Burgos	—	—	250	—	1970	
CENUSA	Madrid	—	—	250	—	1972	

Fuel processing plant at Andalujar.

SWEDEN

Research Reactors

Owner	Location	Name	Type	Power (MWt)	Function	Critical	N.E. Ref.
AB Atomenergi	Stockholm	R–1	D_2O	0.9	Research	1954	
AB Atomenergi	Studsvik	R–0	D_2O	—	Protection and spectrum measurements	1959	
AB Atomenergi	Studsvik	R–2	MTR	30	Materials testing, research	1960	June 1960. 280
AB Atomenergi	Studsvik	R2–0	Pool	5W	Criticality experiments	1960	Aug. 1960. 372

Power Reactors

Owner	Location	Name	Type	Power (MWe)	Main supplier	Critical	N.E. Ref.
AB Atomenergi	Agesta	R3–Adam	D_2O	10+55MWt	ASEA	1964	May 1960. 202
State Power Board	Marviken	R4–Eve	D_2O	100	AB Atomenergi ASEA–NOHAB	1967	
A.K.K.	Simpevarp (East Coast)	—	BWR	60	—	1965	Nov. 1960. 492

There are processing plants at Kvantorp, Studsvik and Ranstad. A heavy water plant is located at Kvarntorp.

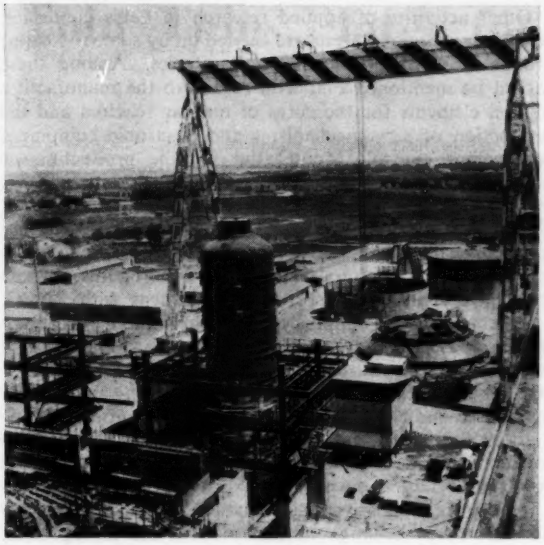
SWITZERLAND

Research Reactors

Owner	Location	Name	Type	Power (MWt)	Function	Critical	N.E. Ref.
Reaktor A.G.	Würenlingen	Saphir	Pool	1	Materials testing, research	1957	
University of Geneva	Geneva		AGN–201		Research and training	1958	
University of Basle	Basle		AGN–201		Research and training	1959	
Reaktor A.G.	Würenlingen	Diorit	(D_2O–D_2O)6	20	Materials testing, isotopes	1960	July 1960. 326

Power Reactors

Owner	Location	Name	Type	Power (MWe)	Main supplier	Critical	N.E. Ref.
ETH Zurich	Zurich	Eth	D_2O	5	Sulzer et al.	Project	



The fourth boiler being installed at Latina which TNPG are building in conjunction with AGIP Nucleare. The thermal dome and welding area can be seen in the background.

for Nuclear Energy (CNEN). This is a specialized organization assisting, as a consultative body, the various Government administrations in the co-ordination of the peaceful uses of nuclear energy. At the same time, the CNEN carries on its own work in fundamental and applied research of particular interest for the development of the peaceful exploitation of nuclear energy. Furthermore, the function of promoting and encouraging the technical training of the various categories of atomic personnel is under its jurisdiction. Finally, the CNEN exercises control and technical supervision over the construction and the proper operation of the nuclear power plants.

Power Programme

From the very beginning, the greatest efforts of Italian industry have been directed towards the application of nuclear energy which offers the greatest potential for the future, namely the production of electric power, the prospects in Italy being more favourable than in other nations. Because of its particular power situation, Italy will certainly be, in fact, among the first countries where energy produced by nuclear plants will become economically competitive as against that produced by conventional power plants. In anticipation of the contribution that (it is hoped) nuclear energy will furnish in meeting the demand of the Italian energy budget, the Italian electrical industry has shown, from the start, a close interest in nuclear plants, and has prepared its plans for the construction of some.

It should, however, be kept in mind that at present, in Italy, the production cost of nuclear energy, even on the assumption of a particularly high load factor, is notably higher than that of the energy obtained from conventional power plants. The power projects already in progress, due to the joint initiative of both the private and public Italian industry, have therefore been undertaken not so much with the purpose of meeting the increasing demand for electric power as—and above all—with the aim of acquiring through these first nuclear plants, the necessary experience for further developments. In consideration of the fact that this interest is shared by all Italian industrial circles, and not only by the electrical ones, the largest Italian industrial concerns, both private and public, have deemed it opportune, in view of the novelty and complexity of the problems relating to the utilization of nuclear energy, to unite their efforts and to bring into being some new companies. In these they have joined their men and their technical and financial means, concentrating thus their nuclear activities and interests.

At present, three projects have materialized, namely those of Società Elettronucleare Italiana (SELNI), Società Elettronucleare Nazionale (SENN) and AGIP Nucleare. Some of the principal electrical utilities of Central and Northern Italy, as well as some industrial firms of the same areas, have concentrated their interests in the activities of SELNI, in which they have been joined by Electricité de France, who will thus be able to acquire useful experience in the field of pressurized water reactors. SELNI, in fact, is preparing to build a nuclear plant in Northern Italy with a net electric power of 165 MW, equipped with a PWR. The study of this plant began at the end of 1955 by the Società Edisonvolta. Following a series of agreements, this project was spread over a wider basis in 1957 and transferred to SELNI. The plant will be located in Trino (Vercelli) and will take the name of Enrico Fermi. The principal supplier of the nuclear section will be the Westinghouse Electric Corporation, while the construction of the conventional section will be entrusted entirely to the Italian manufacturing industry.

The electrical utilities, operating mainly in Central and Southern Italy, have on the other hand merged their interests in the Società Elettronucleare Nazionale (SENN), in which also some electro-mechanical and metallurgical companies of the IRI Group are participating. This company has already begun, in Southern Italy, at the mouth of the Garigliano river, the construction of a nuclear power plant with a net electric power of 150 MW, equipped with a BWR. The SENN plant, which since the beginning of the year has been included in the programme of the Euratom-U.S.A. agreement, will be supplied by the International General Electric Co. Also in this case, a large part of the machinery and equipment of the plant will be supplied by Italian industrial firms.

These two companies are grouping, besides some mechanical and metallurgical firms, the largest Italian electrical utilities, largely private, in SELNI and Government-controlled (IRI) in SENN.

To them should be added the project of AGIP Nucleare, a company controlled by the Government Group IRI. AGIP Nucleare is building in Southern Italy a gas-cooled graphite moderated nuclear plant with a net electrical power of 200 MW, which will be supplied by the British consortium, The Nuclear Power Group (TNPG). This plant, with a natural uranium reactor, is located at Latina and it will be operated on behalf of AGIP Nucleare by the Società Italiana Meridionale Energie Atomica (SIMEA), a company controlled by AGIP Nucleare itself.

Other new projects in the field of power reactors have been announced, but up to now they have not taken a definite form. It should be remembered here that the final goal of the Italian industry is—before entering the long-term programmes—obtaining, through actual experience acquired during the construction and operation of the first plants, the necessary data for more precise evaluations. From this viewpoint, Italy is in a truly exceptional position for, in a few years' time, Italy will benefit from the widest and most varied experience, both from the technical and economic aspects, as there will be working plants belonging to each of the three types that at the present moment seem to be fit for the first experiments on

an industrial scale. Furthermore, thanks to these constructions, the Italian manufacturing industry will be placed in the position of equipping its facilities, so as to be able to meet in future the demands of this new branch of technology.

It should in fact be borne in mind that, although for the realization of these first plants Italian industry had to place orders with foreign manufacturers, a considerable part of both the conventional and nuclear equipment will be supplied, as already mentioned, by the principal Italian mechanical and electromechanical industries, such as Tosi, Ansaldo, Terni, Cornigliano, Marelli, etc. With the construction and operation of these plants, it will at last be possible to train efficiently an appropriate number of technicians at all levels, thus contributing to the solution of a problem of fundamental importance to the development of this new productive field.

Applied Research

Although remarkable efforts have been concentrated on the production of electric power from nuclear energy, at the same time Italian industry, well aware of the importance of applied research for the development of nuclear activities, has undertaken, with equal interest and care, some projects in this direction. As already mentioned, as early as 1946, a group of industries brought into being CISE. The organization of CISE includes at present laboratories of chemistry, electronics, nuclear physics, solid state physics, nuclear engineering and technologies, supported by three central services: workshop, general documentation and health physics units, which have been recently located in a very modern centre in the outskirts of Milan. CISE has worked since its beginning in the field of applied nuclear research, carrying out studies and experiments, training a research staff and carrying on researches, consulting services and design on behalf of the financing companies and third parties. It has given, and continues to give, in this way, a valid contribution to the development of nuclear activity in Italy.

Through the initiative of the two largest private industrial mechanical (Fiat) and chemical (Montecatini) companies, both interested, even if in different branches, in the utilization of nuclear energy, the Società Ricerche Impianti Nucleari (SORIN) was established in 1956. SORIN has erected in Saluggia (Vercelli) a nuclear research centre suitable for the programmes of particular research in which the two companies are interested, such as the production of special nuclear materials and of organic and inorganic moderators, manufacture of nuclear reactor components, nuclear ship propulsion, fabrication and reprocessing of fuel elements, irradiation of agricultural products and production of radioisotopes.

The Saluggia centre, the largest entirely private research centre in Europe, contains, besides radiochemistry, physics, metallurgy and waste disposal laboratories, a research swimming pool reactor, Avogadro RS 1, with a maximum power of 5 MW(t), which to a notable simplicity of operation adds the availability of a wide space for experiments and a remarkable operating flexibility.

To the applied research activities performed in the above-mentioned centres, are to be added the national programmes of the State through the CNRN. The Centro di Richerche Nucleari di Ispro (Varese) is now the common centre of the European Atomic Community (Euratom). The Centro di Studi Nucleari della Casaccia has recently been completed by CNRN near Rome. The Laboratori Nazionali del Sincrotrone di Frascati and a number of Universities are also concerned in the Italian programmes in the fields of fundamental research.

Other activities of applied research in fields connected with their specific interests are carried on by some industrial groups in their own nuclear laboratories. Among these should be mentioned Fiat with regard to the manufacture of fuel elements for the cores of nuclear reactors and the production of servomechanisms and electronic equipment for reactor control; Montecatini for the production of organic moderators, of aluminium and zirconium alloys, of uranium oxide, and so on and, lastly, AGIP Nucleare, whose research programme is addressed to some particular technological problem connected with the development of gas-cooled, graphite moderated reactors. For this purpose they have signed a co-operation agreement with TNPG.

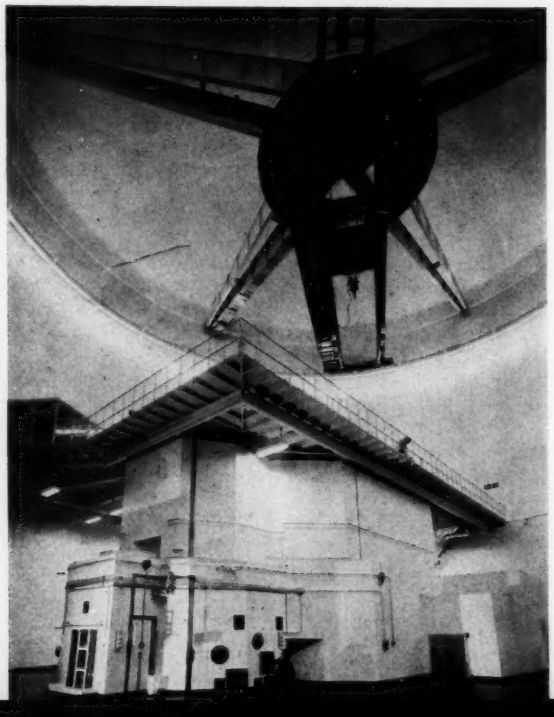
To complete this summary, the programme agreed upon by the National Committee, AGIP Nucleare and SORIN for the development, design and construction in Italy of a 30 MW(t) prototype plant equipped with an organic moderated and cooled reactor, should be mentioned.

In 1958, the different Italian nuclear circles founded the Forum Italiano dell'Energia Nucleare, a non-profit Association whose purpose is to provide a meeting-point, a platform of union and discussion, a service for the diffusion and exchange of information, for all agencies, industrial firms and professional people interested in the development of the peaceful uses of atomic energy in Italy. This "Forum" has recently formed, in union with the similar Associations of other European countries, the "Forum Atomique Européen."

Conclusions

Thanks to the initiative taken in the domains of research and power production, Italy is regaining her proper place among the industrial nations in the nuclear field and it is getting ready to exploit, in the near future, this new source of energy upon which the hopes of the world are directed for the fulfilment of its future power requirements. It is not easy to foresee when this will happen, but it is certain that when nuclear energy becomes competitive with the conventional methods—and this, as we have seen, may happen in Italy sooner than elsewhere—nuclear projects will develop in Italy with intensity and rapidity, and the Italian industry will be ready to give its active contribution to this development.

Avogadro RS 1, a 5 MW research reactor supplied by AMF to the Saluggia centre.



Thin Tube Plates for H.P. Heat Exchangers*

by D. E. HARTLEY, M.A.
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Heat exchangers designed to operate at high pressures often have tube plates several inches thick. Such plates are heavy to handle, difficult to drill, difficult to tube and expensive. Invariably, however, the tubes themselves have only $\frac{1}{16}$" walls—a striking disparity in metal thicknesses. The first part of this article aims to show that in certain cases tube plates could be utilized of similar thickness to the walls of the tubes. In the second part the author presents experimental evidence which supports the theory.

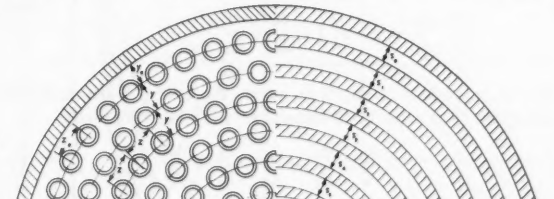
Part 1. Theoretical Aspects

HEAT exchangers designed by present day methods to operate at high pressures often have tube plates several inches in thickness. Taking one example, the exchangers for generating steam at 600 p.s.i. from water at 2,000 p.s.i. associated with a PWR may have tube plates more than 8 in. thick. Such plates are heavy to handle, difficult to drill, difficult to " tube " and expensive. At the same time the tubes in the unit cited have only $\frac{1}{16}$ in. walls ($\frac{1}{2}$ in. o.d.) giving a disparity in metal thicknesses which is very striking. Many engineers not directly involved in estimating heat exchanger stresses must have noted the very small areas of tube sheet between tube holes and wondered if the heavy tube plate metal was really necessary. The first part of this paper aims to show theoretically that in certain cases tube plates having thicknesses of the same order of magnitude as those of the tubes may be employed at high pressures; the second part presents some experimental evidence which supports the theory.

Using the approach outlined, a heat exchanger would be designed as a whole, such that the principal pressure loads were carried by the shell and the tubes themselves, leaving the tube plate with the relatively simple task of withstanding the pressure loads over the small areas between adjacent tubes. Such a method must exclude exchangers of the " hairpin " variety as their tubes cannot be employed as tie bars or struts.

The stiffening effect of tubes on tube plates was recognized and elegantly estimated by Miller[1] and his paper is the basis of the design procedure in the new British Standards Specification (B.S.S. 1500, 1958)[2]. Miller considers the plate as a continuous disc, weakened by the tube holes and strengthened by the tubes. The present analysis differs from Miller's in so far as the tube sheet is simulated by a series of concentric annular beams supported rigidly at their edges by the tubes.

It shows that when the tube plates are thin bending is restricted to a narrow outer zone of the plate; this has been confirmed experimentally. The question of ligament efficiency does not arise and it is possible to see the significance of the main parameters. Also the precise tube arrangement at the all important outer edge of the plate can be taken into account.



Figs. 1(a) and (b).—Showing the nomenclature in discussing a typical tube plate and its analogue.

The work as a whole provides new theoretical and experimental data but does not lay down a crystallized design procedure, since to obtain the most from thin plates requires a design method based on the little explored plastic properties of thin metal.

Analysis of the Stresses and Deflections

Consider a heat exchanger having two tube plates. These plates are subject to:

(i) the surface pressures;
(ii) the loads in the tubes;
(iii) a peripheral load due to the pressure in the header;
(iv) a load from the shell due to its change in length relative to the tube nest, caused both by pressure and temperature.

If the tube sheet is flexible any deflection between the shell and the outer row of tubes will be quickly damped out as the loads will be transmitted into the tubes. Hence in most cases the worst stress conditions will be in the outer one or two quasi-annular rings of tube sheet, and it is, therefore, expedient to simulate the tube sheet by a series of annular rings as shown in Fig. 1(b).

The effective width of the strips will be taken as

$$s = y - \pi d^2/4z \tag{1}$$

except in the case of the outermost element where the span s_o is

$$s_o = y_o - \pi d^2/8z_o. \tag{2}$$

Consider the longitudinal deflections of the tubes and plate elements. For the tube plate element (see Figs. 1–3)

$$\delta_h = K_h V \tag{3}$$

and for the tubes

$$\delta_t = K_t T. \tag{4}$$

From ordinary beam theory,

$$K_h = s^3/E_h z h^3 \tag{5}$$

and thinking of one-half of the tube length,

$$K_t = L_t/2a_t E_t. \tag{6}$$

The flexibility ratio of the tube plate to the tubes is then defined by

$$\phi = \frac{K_h}{K_t} = \frac{2s^3 a_t E_t}{h^3 z L_t E_h}. \tag{7}$$

A flexible tube plate will thus have a large value for ϕ; for the analysis which follows to be acceptable, it is found that ϕ must exceed unity.

The direct pressure load acting on the annular areas o plate can be readily obtained and the resulting stresses calculated; to obtain the total stresses the deflections of the

* The work described in these articles was done when the author was with The Superheater Company, Limited, and Heat Exchangers, Ltd. The views expressed are not necessarily the official views of The Superheater Company.

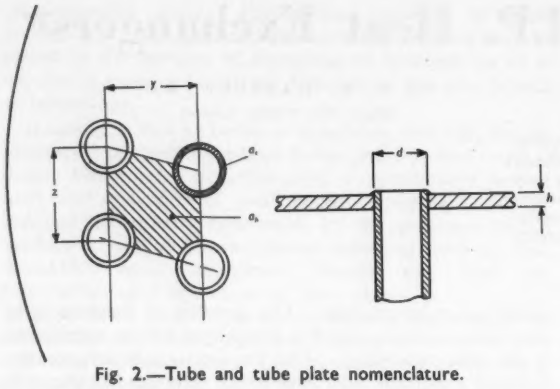


Fig. 2.—Tube and tube plate nomenclature.

plate elements in the axial direction are needed. In Fig. 3, let the tube tensile loads be those caused only by the differential extension of the shell relative to the tube nest.

For the outer strip,

$$\delta_o = K_{ho} V_{10} = K_{ho}(T_o - T_s)/n_1 \tag{8}$$

and similarly for the other elements of plate

$$\delta_1 = K_h V_{12};\ \delta_2 = K_h V_{13}, \text{ etc.} \tag{9}$$

For the tubes,

$$T_1 = V_{10} - V_{12};\ T_2 = V_{21} - V_{23} \tag{10}$$

and for the forces on the plate elements

$$V_{12} n_1 = V_{21} n_2;\ V_{23} n_2 = V_{32} n_3. \tag{11}$$

In terms of the tube extensions,

$$T_1 = \Delta/K_t;\quad T_2 = (\Delta - \delta_1)/K_t$$

and in general

$$T_r = (\Delta - \sum_1^{r-1} \delta_i)/K_t. \tag{12}$$

The aim is to find δ_1/δ_2, δ_2/δ_3, in terms of known parameters. Now,

$$\frac{\delta_o}{\delta_1} = \frac{K_{ho} V_{10}}{K_h V_{12}} = \frac{K_{ho}}{K_h}\left[\frac{\phi\Delta}{\delta_1} + 1\right] \tag{13}$$

and

$$\frac{\delta_1}{\delta_2} = \phi \frac{\Delta - \delta_1}{\delta_2} + 1$$

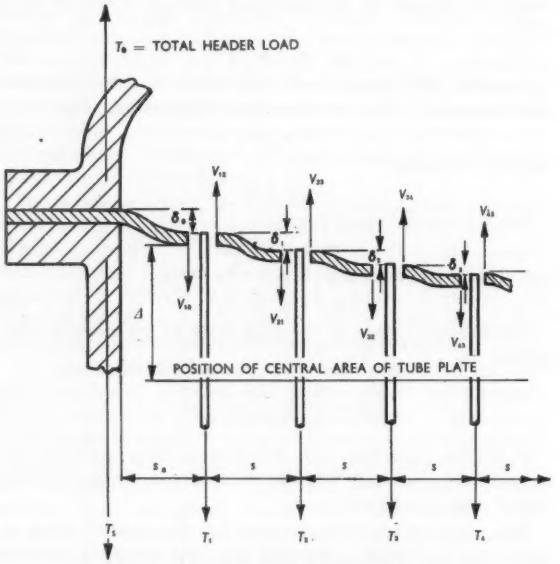


Fig. 3.—Load system due to deflections.

NOMENCLATURE

a_h	Area of tube plate associated with one tube
a_{ho}	Area associated with one of outer row
a_t	Cross sectional area of the metal in one tube
d	Outside diameter of tube
E	Young's modulus, E_h for the tube plate, E_s for the shell, E_t for the tubes
f	Stress, f_{ho} for the outer strip of tube plate, f_h for the tube plate in general, f_t for the tubes
h	Tube plate thickness
K	Deflection per unit load (equns. 3–6), K_{ho} for the outer strip of tube plate, K_h for the other tube plate elements, K_t for the tubes and based on one half of their length, K_s for the shell also based on the semi-length
L	Tube length
n	Tube number in a given row, n_1, n_2, etc.
p_b	Effective pressure load (ref. 2)
s	Effective width, radially, of tube plate elements
s_o	Effective width of outermost strip of tube plate:
T	Tensile force, T_o in the header, T_s in the shell, T_1, T_2, etc. forces per tube due to tube plate overall bending in the first, second, etc. rows
V	Load on tube plate element, see Fig. 3
w	Pressure, w_e effective pressure, w_{eo} on outer tube plate element, w_s in the shell, w_t in the tubes
X	Function of ϕ, see equn. 18
y	Radial tube pitch
y_o	Distance from inside shell to centre of tubes in outer row
z	Circumferential tube pitch
z_o	Effective circumferential pitch for outer tube row
α	Thermal coefficient of expansion, α_s for the shell, α_t for the tubes
δ	Deflection of a tube plate element, see Fig. 3
Δ	Total plate deflection between the centre of the outer tube row and the central part of the tube nest
θ	Temperature above ambient, θ_s for the shell, θ_t for for the tube metal
ϕ	Flexibility ratio, equn. 7

and

$$\frac{\delta_r}{\delta_{r+1}} = \phi \frac{\Delta - \sum_1^{r-1} \delta_i}{\delta_{r+1}} + 1 \tag{14}$$

where for simplicity the ratios n_1/n_2, n_2/n_3 of the number of tubes in adjacent rows have been approximated by unity.

Now

$$\Delta = \delta_1 + \delta_2 + \delta_3 + \delta_4 + \ldots \tag{15}$$

So that,

$$\frac{\delta_1}{\delta_2} = 1 + \phi\left(1 + \frac{\delta_3}{\delta_2} + \frac{\delta_4}{\delta_3}\cdot\frac{\delta_3}{\delta_2} + \ldots\right)$$

$$\frac{\delta_2}{\delta_3} = 1 + \phi\left(1 + \frac{\delta_4}{\delta_3} + \frac{\delta_5}{\delta_4}\cdot\frac{\delta_4}{\delta_3} + \ldots\right) \tag{16}$$

and even with ϕ as small as unity, the terms in the series in equation (16) rapidly diminish, so that we may write

$$\frac{\delta_1}{\delta_2} = \frac{\delta_2}{\delta_3} = \frac{\delta_3}{\delta_4} = \frac{\delta_4}{\delta_5} = \frac{\delta_5}{\delta_6} = X. \tag{17}$$

The series may be taken as being infinite to a good accuracy when ϕ is greater than one, hence

$$X = 1 + \phi\left(1 + \frac{1}{X} + \frac{1}{X^2} + \frac{1}{X^3} + \ldots\right)$$

giving

$$X = 1 + \frac{\phi}{2} + \tfrac{1}{2}\sqrt{(4\phi + \phi^2)}. \tag{18}$$

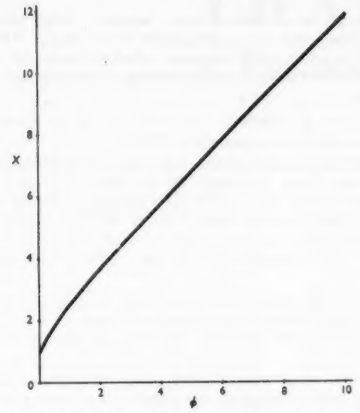


Fig. 4.—The function X against different values of ϕ.

The alternative value of X given by the quadratic equation relating it to ϕ is inadmissible since it is less than unity and such a value would make the series $\sum_{i=0}^{i=\infty} \frac{1}{X^i}$ divergent.

Fig. 4 shows values of X for ϕ between 0 and 10. When $\phi > 10$, $X \simeq \phi+2$. The following table (1) shows the way in which the deflections in the outer parts of tube plates

TABLE 1.—Deflection shapes of thin tube plates

ϕ	X	δ_2/δ_1	δ_3/δ_1	δ_4/δ_1
1	2.62	0.382	0.146	0.056
3	4.80	0.208	0.044	0.009
10	11.93	0.083	0.007	0.001

vary with the flexibility ratio ϕ. Fig. 5 shows some of these bending shapes also, and it is clear that any deflections of thin tube plates are restricted to the outer edges of the plates, so that it is in this region where the biggest stresses will occur.

The total deflection of the plate between the first row of

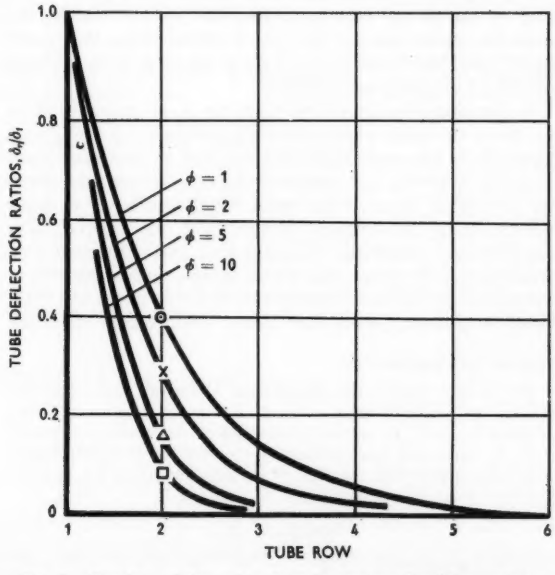


Fig. 5.—Bending of thin tube plates for various flexibility ratios.

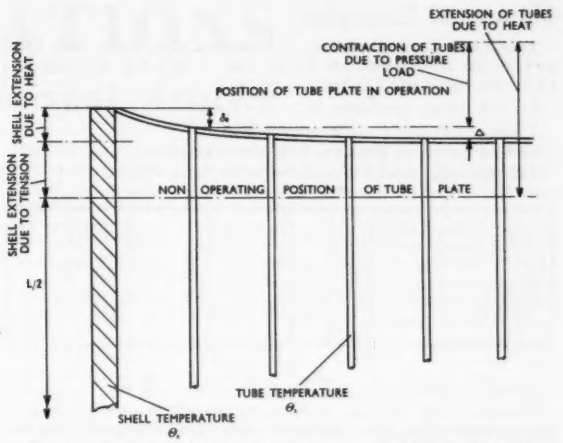

EXTENSION OF TUBES DUE TO HEAT
CONTRACTION OF TUBES DUE TO PRESSURE LOAD
POSITION OF TUBE PLATE IN OPERATION
SHELL EXTENSION DUE TO HEAT
SHELL EXTENSION DUE TO TENSION
NON OPERATING POSITION OF TUBE PLATE
L/2
TUBE TEMPERATURE
SHELL TEMPERATURE

Fig. 6.—Tube plate bending under pressure and thermal loads.

tubes and the central part of the tube nest is Δ, and using equations (15) and (17),

$$\Delta = \frac{\delta_1 X}{(X-1)}. \tag{19}$$

It is now possible to examine the tube plate stresses.

Tube Plate Stresses

The maximum total stress in the outer element of tube plate is

$$f_{ho} = \frac{w_{eo} s_o^2}{2h^2} \pm \frac{3E_h \delta_o h}{s_o^2} \tag{20}$$

where the effective pressure w_{eo} is given by

$$w_{eo} = w_i(1+a_i/a_{ho}) - w_s. \tag{21}$$

In the second and subsequent layers of tube plate the stresses are given by (20) and (21) if the suffices zero are omitted. It remains to obtain values for δ_o, δ_1, δ_2.

Making use of equations (8) to (19),

$$V_{01} = T_1 + V_{12},$$

i.e.
$$\frac{T_o - T_s}{n_1} = \frac{\Delta}{K_t} + \frac{\delta_1}{K_h} = \frac{\Delta}{K_t} + \frac{\Delta(X-1)}{K_h X}.$$

Hence

$$\Delta = \frac{(T_o - T_s)}{n_1} \frac{K_h}{(X-1)} \tag{22}$$

so that

$$\delta_1 = \frac{(T_o - T_s)}{n_1} \frac{K_h}{X} \tag{23}$$

and

$$\delta_o + \Delta = \frac{(T_o - T\Delta_s)}{n^1}\left[K_{ho} + \frac{K_h}{(X-1)}\right] \tag{24A}$$

Referring to Fig. 6, the total deflection of the plate is also

$$\delta_o + \Delta = T_s K_s + w_s a_h K_t + (\alpha_s \theta_s - \alpha_t \theta_t)\frac{L}{2} \tag{24B}$$

Thus the two equations (24) give a means for obtaining T_s in terms of known quantities. Having found T_s, the values of δ_o, δ_1, and Δ are given by equations (8), (23) and (19). The tube plate maximum stress is then found by equation (20).

Tube Stresses

The greatest longitudinal tube stress must be either in the central part of the nest or in the outermost row. In the former case it is simply

$$f_t = -w_s a_h/a_t \tag{25}$$

and in the latter case

$$f_{t1} = -w_{eo} a_{ho}/a_t + \Delta/a_t K_t. \tag{26}$$

Numerical Examples

Take a heat exchanger having 217 stainless steel tubes, with 1,000 p.s.i. in the tubes which are 0.5 in. o.d. × 16 s.w.g. enclosed in a 12 in. bore shell, and 2 ft long.

Let the design conditions be :

Tubes: 1,000 p.s.i.g., 70°F above ambient.

Shell: atmospheric pressure, 20°F above ambient.

The tube arrangement is as shown in the table below:

Row	1	2	3	4	5	6	7	8	9
n	48	42	36	30	24	18	12	6	1
PCD (in.) ..	11	$9\frac{5}{8}$	$8\frac{1}{4}$	$6\frac{7}{8}$	$5\frac{1}{2}$	$4\frac{1}{8}$	$2\frac{3}{4}$	$1\frac{3}{8}$	0

Circumferential pitch = 0.72 in., radial pitch = $\frac{11}{16}$ in.

The shell is not specified, so let it be estimated in such a way as to give a perfectly flat tube plate under design conditions, and after that find the effects of small temperature changes.

Employing equation (24B) it is found that a mild steel shell 0.30 in. thick leads to $\Delta + \delta_o = 0$; i.e. the pressure and thermal extensions of the shell and tube nest are identical.

Then in equation (20) only the first term is relevant and with $w_t = 1{,}000$ p.s.i., $w_{eo} = 1{,}300$ p.s.i., $h = 0.064$ in., $s_o = 0.369$ in. the stress at the outer edge of the plate is

$$f_{ho} = 21{,}600 \text{ p.s.i.}$$

Over the rest of the tube plate, $w_e = 1{,}270$ p.s.i., $s = 0.415$ in., and the stress is

$$f_h = 26{,}600 \text{ p.s.i.}$$

These stresses are a little above the design stress of 19,600 p.s.i. for 18/8 stainless steel plate so that a stainless steel with an ultimate strength of 48 t/in.^{2} appears to be needed. Alternatively the tube pitch could be diminished a little or the tube plate thickness slightly increased. It will be seen later, in connection with the experimental work, that the difference between the estimated stresses and those usually accepted for 18/8 stainless are not very significant.

If the formula for a box-type exchanger in B.S.S. 1500 (ref. 2) is applied to the example the tube plate stress obtained is zero. This is because the Miller theory treats the tube plate as a continuous circular plate in which the stresses are associated with the bending of the central plane of the plate. Thus in designing for a flat tube plate under operating conditions ($p_b = 0$ in B.S.S. 1500) zero stress is implied. With normal tube plates the pressure stresses for the areas between tube rows will, of course, be very small, and it is only for very thin tube plates where they need be estimated. The analysis in the present paper does not contradict Miller's work, it is simply that it applies to a different range of tube plate flexibility.

Since the zero stress from the B.S.S. 1500 formula and the zero deflection stress in the thin plate theory both depend on particular temperature and pressure conditions in the tubes and the shell, what happens if the exchanger needs to operate under some different (say) temperature conditions? To throw light on this question the stresses in the exchanger of the example have been estimated under the same conditions as before except for a reduction of 10°F in the temperature of the tube metal.

According to the thin plate theory,

$$K_{ho} = 9.1 \times 10^{-6},\ K_h = 13.5 \times 10^{-6},\ K_t = 4.87 \times 10^{-6}$$
$$\phi = 2.77,\ X = 4.55,$$

leading to

$$T_s = 0.972\ T_o,\ \delta_o = 0.6 \times 10^{-3},\ \Delta = 0.25 \times 10^{-3},$$
$$f_{ho} = 21{,}600 \text{ (pressure)} + 23{,}600 \text{ (bending)},$$
$$\text{i.e. } f_{ho} = 45{,}200 \text{ p.s.i.}$$

The British Standards formula gives:

$$p_b = 683 \text{ p.s.i. and } f_h = 43{,}500 \text{ p.s.i.}$$

As B.S.S. ignores the element pressure stress, it estimates about twice the bending stress given by the present theory.

This is interesting, but more interesting still is the fact that a deflection of only 0.0006 in. in the outer element of plate gives a calculated stress greater than that resulting from the 1,000 p.s.i. pressure load. Before discussing these deflection stresses, an example will be considered in which the high pressure is on the shell side of an exchanger.

Exchanger with 1,000 p.s.i. in Shell

The design conditions in the example of the previous section correspond to a typical case of an air compressor intercooler. In this section the pressures and temperatures will be taken appropriate to an exchanger for a boiling water reactor. High pressure water will be in the shell with steam generation in the tubes. The exchanger geometry will be taken to be the same as before except for the material and thickness of the shell. The operating conditions are:

Shell: 1,000 p.s.i.g., 526°F.

Tubes: 475 p.s.i.g., 496°F.

(Ambient temperature assumed 60°F.)

In order to minimize the stresses resultant on the differential thermal expansion of the tubes and shell, let the shell be in 18% Cr, 9% Ni and the tubes in 17.5% Cr, 12% Ni austenitic stainless steels. For example, the Firth-Vickers steels "Staybrite FDP" and "Staybrite FCB(T)" which have thermal coefficients of expansion 17×10^{-6} °C and 18×10^{-6} °C respectively in the temperature ranges being considered.

Calculation of the shell thickness needed to give an ideal flat tube plate (in operation) leads to an unpractical figure of a little under 3 in. The shell thickness will therefore be based on normal estimates and taken as $\frac{5}{8}$ in.

The thin tube plate theory then gives an edge deflection δ_o of 0.56×10^{-3} in., and a stress in the outer rim of tube plate

$$f_{ho} = 6{,}550 \text{ (pressure)} + 20{,}000 \text{ (deflection)},$$
$$\text{i.e. } f_{ho} = 26{,}600 \text{ p.s.i.}$$

Ref. 2 estimates $p_b = -494$ p.s.i. and $f_h = 33{,}600$ p.s.i.

The tube plate would appear to require an austenitic stainless steel somewhat stronger than 18/8, for instance a 20/7.5 (Firth-Vickers "Immaculate 2W"). In actual fact, ordinary 18/8 would be satisfactory in this design as will be apparent from the experimental work described in Part 2.

Discussion

The analysis has shown that when a tube plate is sufficiently flexible ($\phi > 1$) the bending in it is restricted to the outer few rows of tubes, the main central area of plate remaining flat. The maximum stress thus arises in the outer edge of the plate or else in the region between the first and second rows of tubes.

The examples suggest that 16 s.w.g. stainless steel tube plates may be satisfactory for use with pressures of about 1,000 p.s.i. in either the tubes or the shell. With more closely pitched tubes, higher pressures can be considered. The shell material and its thickness need to be carefully chosen in order to keep to a minimum the overall bending of the tube plates. For this reason, there may be heat exchanger design conditions for which thin tube plates cannot be used. Where thin tube plates are concerned the actual plate thickness is dependent on the local conditions of tube pitch rather than on the overall tube plate diameter, so that whereas the examples taken were for a 12 in. diameter plate, they could equally well have been for (say) a 4 ft diameter plate without affecting the tube plate stresses.

A disturbing feature of the estimates is the powerful effect on stress of small temperature fluctuations from a design condition. The same effect is given also in estimates based on B.S.S. 1500 for box type exchangers. If thin tube plates are in fact as sensitive to small (thousandths of an inch) deflections as the estimates would have one believe, there would be no possibility of using thin plates for real heat exchangers. However, the experimental work described in the second part of this work shows that thin metal can withstand far greater strains than elastic beam theory indicates.

ACKNOWLEDGMENTS

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TRANSLATIONS

A Résumé of Principal Articles

La plus grande partie du présent numéro est consacrée à une revue des compagnies et entreprises qui consacrent toute ou partie de leur activité à la fabrication d'équipements et de matériaux utilisés dans l'industrie nucléaire. Ce panorama couvre l'Europe occidentale à l'exclusion du Royaume-Uni.

Il est introduit par une série d'articles préparés spécialement à l'intention de "Nuclear Engineering" par des personnalités marquantes de l'industrie nucléaire continentale. Ces articles, en général, décrivent l'organisation de l'industrie nucléaire dans chaque pays. En même temps ils mettent l'accent sur les techniques particulières qui ont été mises au point par diverses compagnies soit en collaboration étroite avec le commissariat a l'énergie atomique du pays intéressé, soit sous licence en vertu d'accords avec les industriels anglais ou américains fabriquant des réacteurs. Un bilan est ensuite présenté par "Nuclear Engineering". Ce dernier a été dressés aprés consultation de plusieurs personnalités de l'EURATOM et de l'AGENCE EUROPEENE DEL'ENERGIE NUCLEAIRE.

En outre, un répertoire des industriels continentaux comportant deux parties est donné en supplement. Il comporte: (a) l'adresse de chaque compagnie et celle des ses principaux associés. Mention est faite des fournitures qui ont été livrées lors de la construction d'installations nucléaires; (b) un répertoire qui devrait faciliter les recherches des futurs acheteurs d'équipement nucléaire dans chaque pays.

Buts et fonctions des Forums Atomiques (540)

La réalisation d'un programme d'énergie nucléaire pose des problèmes non seulement technologiques, mais qui ont également un aspect administratif, légal et financier, intéressant directement la communauté. Pour discuter de ces questions, divers forums ont été crées aux Etats Unis et en Europe. Les forums européens viennent de constituer une organisation commune appellée FORATOM pour coordonner les activités et stimuler le progrès des forums déjà établis.

Tôles minces pour embases d'échangeurs de chaleur à haute pression (557)

Les échangeurs de chaleur fontionnant sous des pressions élevées sont souvent fixés à des embases épaisses de plusieurs centimètres. Ces dernières sont lourdes à manipuler, difficiles à percer et côuteurses; enfin, la mise en place des tubes est délicate. Par contre, les tubes eux mêmes n'ont que 1 à 2mm d'épaisseur et cette difference d'épaisseur est frappante. Le présent article montre qu'il est possible dans certains cas d'utiliser des tôles d'épaisseur comparable pour l'embase et pour les tubes.

L'éxposition atomique de San Francisco (565)

La seconde exposition nucléaire aux Etats-Unis, cette année, aura lieu a San Francisco du 12 au 16 décembre prochain. Le présent numéro contient une description préliminaire des stands et une liste complète des exposants. Nuclear Engineering *sera représenté au stand des périodiques consacrés a l'énergie nucléaire. L'exposition est patronnée par le Forum américain de l'énergie atomique.*

Der Hauptteil dieser Ausgabe ist einer Uebersicht der vorhandenen Einrichtungen zur Fabrikation der Materialien zur Ausnutzung der Kernkraft und der zugehörigen Betriebe auf dem Kontinent in Europa gewidmet unter Ausschluss Englands und der Länder in Ost-Europa, die unter dem Einfluss der V.S.S.R. stehen.

Der Uebersicht geht eine Einführung voraus, die aus einer Reihe von Aufsätzen besteht, die speziell für "Nuclear Engineering" von den anerkannten Führern der Atomkraft-Industrie auf dem Kontinent geschrieben sind. Diese Aufsätze erklären ganz allgemein, wie die Industrie in jedem Lande organisiert ist, und beschreiben, in grossen Zügen gleichzeitig, wie die besonderen Arten der Fertigungstechnik sich bei den verschiedenen Gesellschaften entwickelt haben, entweder durch enge Zusammenarbeit mit den stattlichen Behörden zur Ausnutzung der Kernkräfte, oder auf Grund von Lizenzen, die mit den Fabrikanten von Reaktoren in den Vereinigten Staaten oder in England vereinbart worden sind.

Die Uebersicht wird ergänzt durch einen Führer, der eine Liste der Fabrikanten auf dem Kontinent enthält. Der Führer besteht aus zwei Teilen: (a) Ein Adressenteil, in dem jede Gesellschaft eingetragen ist, und der Einzelheiten gibt über assoziierte Firmen und über die tatsächlichen Lieferungen, die bereits an Kernkraft-Organisationen gemacht werden; (b) eine Klassifizierte Liste, die solchen Firmen in den Ländern, die vielleicht beabsichtigen Kernkraft-Einrichtungen zu beschaffen, eine Hilfe sein soll.

Objekt und Arbeitsbereich der Atom-Forums. (540)

Die Verwirklichung eines Programmes zur Ausnutzung der Kernkräfte bringt Probleme mit sich, die nicht nur technologische Dinge betreffen, sondern auch solche, die die Regierungen angehen, die rechtlicher und finanzieller Natur sind, und die die Beziehungen der Gemeinden untereinander betreffen. Es sind deswegen Forums in den Vereinigten Staaten und in Europa geschaffen worden, um eine Plattform zu haben, wo eine Diskussion der Fragen vor sich gehen kann, die hierbei entstehen. Die Forums in Europa haben sich kürzlich zu einer gemeinsamen Organisation unter dem Namen FORATOM zusammengeschlossen, um die Arbeiten zu vereinheitlichen und den Fortschritt der schon bestehenden Forums zu fördern.

Dünne Rohrplatten für Hochdruck-Wärmeaustauscher. (557)

Wärmeaustauscher, die für Betrieb unter hohem Druck konstruiert sind, haben oft Rohrplatten von einer Stärke von mehreren Zoll. Solche Platten sind schwer zu handhaben schwierig zu bohren, schwierig mit Röhren zu besetzen und teuer. Wie dem auch sein, die Rohre selber haben immer nur eine Wandstärke von 1/16 Zoll, und die Austauscher zeigen so eine auffallende Ungleichförmigkeit in der Stärke des Metalls. Der Artikel hat den Zweck zu zeigen, dass in gewissen Fällen Rohrplatten verwendet werden können, deren Stärke der Stärke der Rohrwandungen ziemlich gleich ist.

Die Kernkraft-Messe in San Francisco. (565)

Die zweite Kernkraft-Ausstellung, die in diesem Jahre in den Vereinigten Staaten abgehalten wird, findet in San Francisco statt vom 12. bis zum 16. Dezember. Dieses Heft enthält eine Vorschau der ausgestellten Objekte und eine vollständige Liste der Aussteller.

El contenido principal de este número pasa en revista las facilidades de fabricación existentes para productos y equipos nucleares en el continente de Europa, excluyendo el Reino Unido, y en aquellos paises bajo la influencia de Rusia en Europa Oriental.

Este reconocimiento se presenta en una serie de artículos escritos especialmente para "Nuclear Engineering" por reconocidos "líderes" de la industria manufacturera nuclear en el Continente de Europa. En general, estos artículos explican como está organizada la industria en cada país, y al mismo tiempo bosque jan las técnicas especificas de fabricación que han sido evolucionadas por distintas compañías, ya sea en estrecha cooperación con la autoridad atómica del estado o en virtud de convenios de licencia arreglados por fabricantes de reactores de los Estados Unidos o del Reino Unido. Inclusa en esta serie especial se encuentra la apreciación propia de "Nuclear Engineering" del estado actual de la tecnología nuclear en Europa. Esta apreciación ha sido preparada después de consultar a diversas autoridades principales en la Agencia Europea de Energía Nuclear y la Comisión Euratom.

Suplementando este reconocimiento hay una guia en dos partes de los fabricantes del Continente Europeo. Esta guia consiste de (a) Una sección de direcciones que ofrece una lista de cada compañía y que también da detalles de asociados y de los productos efectivos que ya han sido suministrados a organizaciones nucleares y (b) una sección clasificada, el objeto de la cual es servir de ayuda a los compradores en perspectiva de equipo nuclear en cada país.

Objetos y Funciones de Foros Atomicos. (540)

La implementación de un programa de energía nuclear origina problemas no solo de un carácter tecnológico sino también los de una naturaleza administrativa-gubernativa, legal, financiera y con respecto a relaciones con la comunidad. Para proveer una plataforma para la discusión de asuntos que surgen en esta forma, se han establecido varios foros en los Estados Unidos de Norte América y en Europa. Los foros de Europa han formado recientemente una organización combinada denominada FORATOM para unificar las actividades y para fomentar el progreso de los foros ya establecidos.

Placas Tubulares Delgadas Para Cambiadores de Calor de Alta Presion. (557)

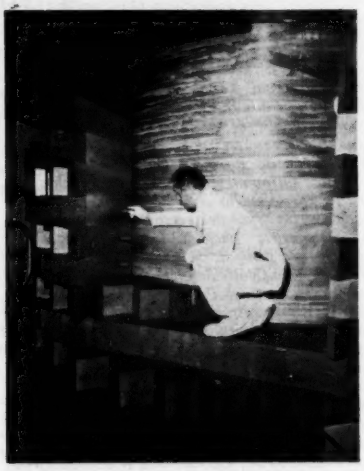
Los cambiadores de calor diseñadós para operar a elevadas presiones a menudo tienen placas tubulares de varias pulgadas de espesor. Placas de esta naturaleza son pesadas para manipular, dificiles de taladrar, dificiles de entubar y costosas. Sin embargo, invariablemente los tubos mismos tienen paredes de 1/16 in., ofreciendo una destacante disparidad en espesores de metal. Este articulo tiene como objeto el mostrar que en ciertos casos se podrían utilizar placas tubulares de espesor similar al de las paredes de los tubos.

"Atomfair" (Feria Atomica) de San Francisco. (565)

La segunda exposición nuclear que va a ser celebrada en los E.E.U.U. este año tendrá lugar en San Francisco desde el 12 hasta el 16 de diciembre. Este número contiene una prevista de los objetos expuestos y una lista completa de los expositores.

Fig. 1.—(Left) Core plug ready for insertion into reflector.

Fig. 2.—(Below) Inserting dowels used for keying the removable side-wall section.



Graphite Reflector for ZED-2

ZED-2, which recently came into operation at Atomic Energy of Canada, Ltd.'s Chalk River site, is a zero energy, heavy-water moderated reactor designed for the testing of full-size fuel lattices corresponding to those of large power reactors. Fuel rods which can be changed by remote control are suspended in heavy water in an aluminium tank 11 ft diameter by 11 ft high which is surrounded by a graphite reflector.

This reflector was designed in detail and constructed by the Atomic Energy Division of the Graviner Manufacturing Co., Ltd., Gosport, Hampshire, under sub-contract to the main contractors for the plant, Foster Wheeler, Ltd., of Canada. It is built up of graphite bricks of varying shapes machined from reactor-quality graphite blocks 30 in. long by 8 in. square. It relies for bond entirely on the precision of the mating surfaces of adjacent bricks. Approximately 16 ft in outside diameter and 18 ft high, the reflector has stepped bores, 11 ft 3.28 in. and 5 ft in diameter, to accommodate the tank and a removable bottom reflector (Fig. 1). The specified tolerances on these bores were $+0 -0.01$ in.; in the event the dimensions have been maintained within 0.005 in. of the design values. There is a removable section in the sidewall for servicing purposes. In addition to the large central bores, there are smaller bores for accommodating pipes for discharging heavy water into dump tanks below the fuel core assembly, and still smaller bores housing fission chambers and instrumentation (Fig. 3). The specification was provided in November, 1958, and it called for delivery by June 15, 1959, an exacting time schedule for such an item of precision equipment.

For producing the large bores, a special machine was developed capable of boring holes up to 16 ft in diameter in a complete course of blocks. At the outset, it was decided that a proof assembly simulating the final arrangement on site 5,000 miles away would be essential in order to check the assembly progress and ensure that the necessary high degree of precision was obtained. A 200 sq. ft machined base was provided with a surface flat to within 0.002 in. on which to erect the reflector, a facility which has proved to be of considerable value since the contract was completed.

After the design drawings had been approved, the company carried out a secondary design study on a scale model made up of wooden blocks in order to find the most satisfactory and economical way of shaping the graphite blocks. A very wide diversity of shapes was necessary to avoid neutron streaming and every individual brick had to be stamped with its identification number to ensure that it would find its proper location on assembly. The removable section in the sidewall posed an extra problem as it destroyed the bond around the door area. Special dowelling was used to key-in the removable section, the bricks in this section being assembled of necessity in a predetermined sequence (Fig. 2).

Very careful production planning was necessary to achieve the specified delivery date. Machining and assembly went hand-in-hand; as soon as one course of bricks had been bored, it was dismantled and reassembled on the trial assembly site while the next course of shaped bricks was set up on the boring machine. After every machining operation, 100% inspection, dimensional and visual, was the order of the day. Throughout the period of manufacture there was close liaison with the main contractor's inspectors.

When the trial assembly was completed and found satisfactory, it was dismantled for packing. Each individual brick was wrapped in polythene and cartoned and a 2-ton load of cartons was packed in a 4 ft cube wooden packing case. Only one block was found to be damaged (this being due to a loading fault) when the cargo arrived at the Chalk River site three days ahead of the specified date. A replacement machined to the correct shape was flown to Chalk River two days later.

On site, the reflector base is well below ground level, and the contractors had to provide forced ventilation for the workers as well as a dust extraction plant to ensure clean conditions for the assembly of the graphite blocks. Graviner's erection supervisor was responsible for training the erection crews, for examining the blocks on arrival and for checking the floor level on site. No unexpected snags arose during erection of the graphite reflector; and this portion of the reactor was completed on schedule.

The satisfactory relations that have been built up between the main contractor and Graviner during the making and erection of ZED-2's graphite reflector are to be perpetuated by a mutual agreement between Foster Wheeler, Ltd., of Canada, and the Graviner Manufacturing Co., Ltd., whereby Foster Wheeler will be the sole agents in Canada and U.S.A. for the U.K. company's graphite enterprises.

Fig. 3.—The first four courses of the reflector with core plug in position.

FUEL HANDLING AT BRADWELL

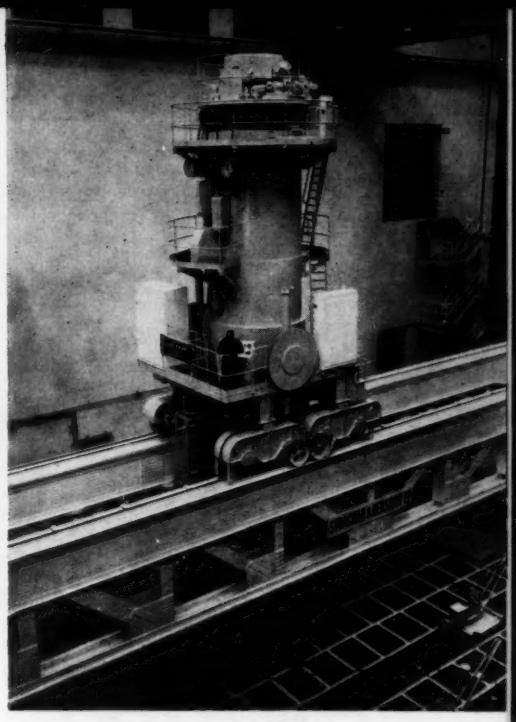
Multi-purpose Machine Completed

INTERESTING comparisons between methods of fuel handling are made possible by the completion of the Bradwell charge - discharge machine which The Nuclear Power Group recently made available for inspection. Designed and manufactured by Strachan and Henshaw, Ltd., this machine is an outstanding example of the philosophy of the "universal" unit as opposed to that of several single-purpose machines. (The Berkeley charge-discharge system, described in *Nuclear Engineering*, April, 1960, p. 164, uses 5-6 separate specialized units.)

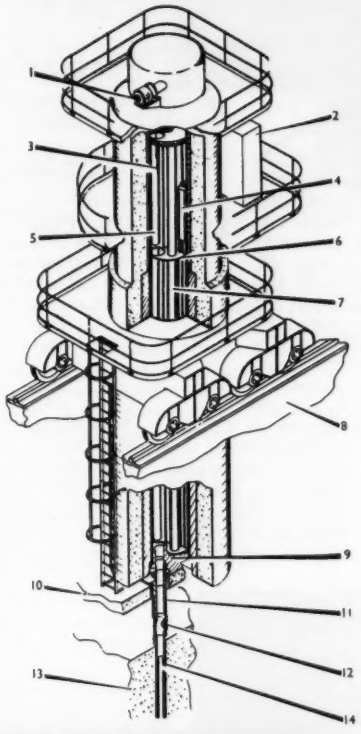
The S. & H. machine at Bradwell, which is 52 ft high, and weighs 400 tons, has storage capacity for three channels of fresh fuel (24 elements) three channels of irradiated fuel, two fuel standpipe plug assemblies and a control standpipe plug. In addition, it carries the charging chute, an element hoist and grab, a service hoist and grab, and can handle absorbers, graphite and steel specimens, and channel gags, into and from, the core.

Positioning the Machine

As will be seen from the illustrations, the machine itself takes the form of a vertical cylinder, which traverses the reactor on a gantry in precisely the same manner as a Goliath crane, the gantry itself being capable of travelling across the reactor at right angles to the traverse, so that by a combination of the two movements, the machine can be located anywhere in the pile cap area. The control for these movements is located on a platform at the base of the machine. Both movements are powered by two-speed motors, with a creep speed of some 6 in./min, and all standpipes and chute headboxes are provided with target plates which can be viewed by periscopic means from the control platform; the machine can, therefore, be located exceedingly accurately over any standpipe.

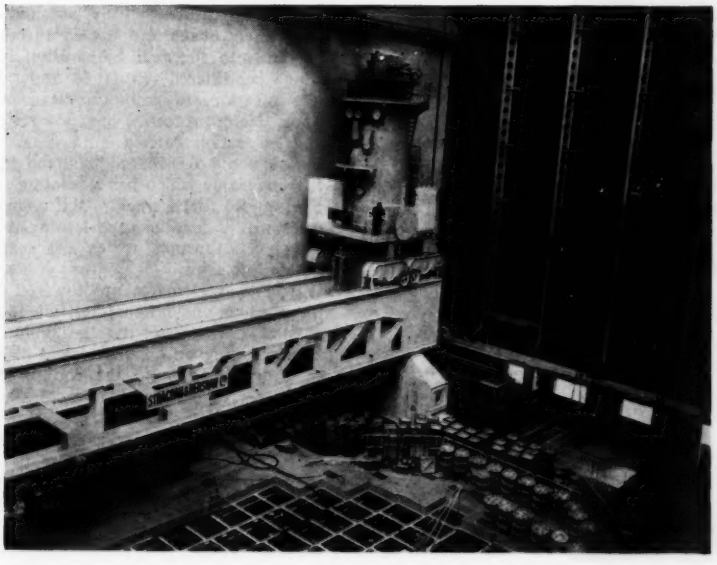


View of machine at centre of gantry.



(Right) Isometric view of machine.
1, Element hoist drive; 2, control cubicle; 3, fuel element grab; 4, element storage tubes; 5, shielding plug storage tube; 6, rotating magazine; 7, charge chute storage tube; 8, traversing gantry; 9, charge machine valve; 10, secondary floor; 11, headbox adaptor and flexible coupling; 12, charge-discharge valve; 13, reactor biological shield; 14, standpipe and charging chute.

(Below) View of machine from visitor's gallery. Machine in fuel loading corner.



Operation

Each of the reactor fuel standpipes gives access to 34 fuel channels. When fuel changing is required, the floor slab above the selected standpipe is removed (by means of the ordinary gantry crane which serves the pile cap) and replaced by a special slab with telescopic shielding and a chute headbox with a telescopic extension is placed on to the standpipe and a gas-tight seal made between the two.

The machine, loaded with fresh fuel and pressurized with clean CO_2 at reactor pressure, is then traversed to the standpipe, and optically located in position. It is then coupled to the standpipe extension by a gas-tight seal, and the telescopic shielding in the slab is raised to interlock with the shielding on the machine, and prevent radiation streaming. The coupling space between the standpipe valve and the machine is then purged and pressurized with clean CO_2.

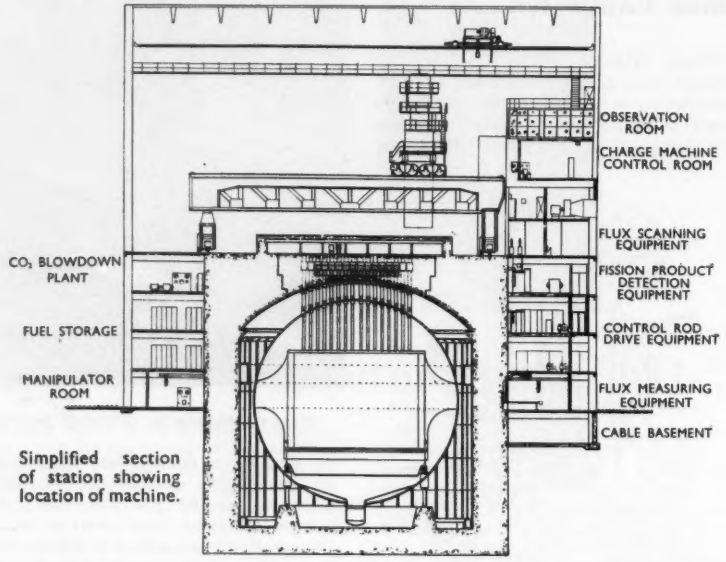
Although there are standby or emergency controls on the machine itself, control of all the machine functions once it is coupled into position are carried out remotely from a shielded control room in a corner of the pile cap area. Here, in addition to the controls, complete instrumentation of all the functions is provided, by indicators of the Selsyn type. The state of three machine functions—the position of the element hoist, the position

of the service hoist, and the position of the rotating turret, are also displayed on mechanically driven dials on the machine itself; these can be observed from the control room by binoculars, if desired.

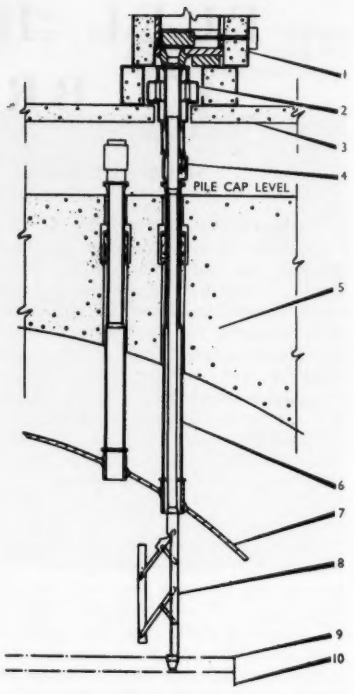
It is also possible to view fuel elements, or other material passing through the throat of the machine, by means of closed-circuit television.

The machine incorporates heavy shielding, and natural cooling for irradiated fuel stored within it.

From the control room, the service hoist is operated first, the shield plug being raised and stored within the machine. Next, the charge chute is lowered into the reactor, and indexed to the desired channel. The irradiated elements are then raised, one by one, into the machine and stored, after which the channel is filled with fresh fuel, one element at a time. The charge chute is then indexed to another channel, and the process repeated. After three channels have been dealt with, the shield plug is replaced (or, if preferred, a fresh plug is inserted leaving the old plug within the machine) the valves are closed, and the machine is uncoupled and traversed, first to an unloading hole to dump the irradiated elements, and then to load fresh fuel, after which the operation can be repeated. The machine is normally capable of changing the three channels in one day (two shifts).



Simplified section of station showing location of machine.



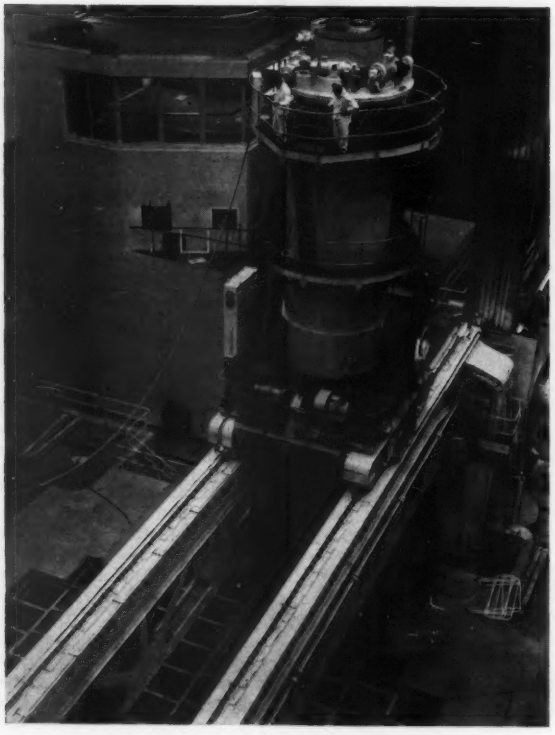
Simplified section of standpipe and charge chute.

1, Charge-discharge machine; 2, chute headbox; 3, secondary floor; 4, charge-discharge valve; 5, biological shield; 6, standpipe; 7, pressure vessel; 8, charge chute; 9, charge pan; 10, core.

To ensure continuity of operation in unforseen circumstances, a second (spare) machine is housed in a bay adjoining the pile cap area.

Fresh fuel elements are received in boxes and stored. They are removed from their boxes and passed through a barrier into the fuel preparation room, which has filtered ventilation under positive pressure, to maintain clean conditions. Here, protective bags are removed and inspection carried out, after which the elements are placed by hand into a fuel magazine which has a rotating turret carrying 24 fuel elements, and communicates with a loading tube leading to pile cap level, through which the machine obtains its load.

Irradiated elements are lowered from the machine via an unloading hole located at the corner of the building, into a skip resting on an underwater carriage in a duct leading to the cooling pond, which serves both of the reactors which compose the station. The pond is spanned by a crane which can lift and carry skips underwater to any position in the pond. At the end of the decay period, skips are placed into a coffin by a coffin crane, and dispatched for reprocessing.



View of machine from fuel loading corner, with control room in background.

San Francisco AtomFair-West

Atomic Industrial Forum Sponsors a Nuclear Exhibition on the U.S. West Coast from December 12 to 16

San Francisco's new Masonic Memorial Building.

MARKING its return to active nuclear trade exhibition management for the first time since 1957, the Atomic Industrial Forum's AtomFair-West provides the visual side to a week of nuclear activities in San Francisco, California, from December 12 to 16. Concurrently, the Forum is holding its annual conference at the Fairmont Hotel (December 14-16) and the American Nuclear Society, co-sponsor of the Fair, holds its winter meeting at the Mark Hopkins Hotel.

The last Forum-managed exhibition was AtomFair '57 at the New York Coliseum in late October of that year, an event which drew some 20,000 visitors in five days. In terms of audience and number of exhibiting organizations, it holds the record for the largest atomic exhibition ever held in the United States. For three successive years thereafter the Forum lent its name and sponsorship to the exhibition staged at an annual Nuclear Congress but terminated this arrangement this past spring to resume its own programme of annual exhibitions in co-operation with the American Nuclear Society.

AtomFair-West will be staged at the new Masonic Memorial Building atop San Francisco's scenic Nob Hill, just two short blocks from both conference hotels; it is expected to draw upwards of 7,500 visitors in its four-day run. Theme of the exhibition: an all-nuclear exhibition for an all-nuclear audience. It has been kept particularly compact in size to limit the expenditures of the exhibitors, whose participation costs run somewhat higher owing to the greater shipping distances for firms east of the Mississippi River. (The AIF-ANS AtomFair '61 is being projected at about twice the size of the 1960 event, to accommodate approximately 120 exhibitors; it will be held during the week of November 6 in Chicago, Illinois, at the Conrad Hilton Hotel, and will be the only full-scale nuclear exhibition in the U.S. in 1961.)

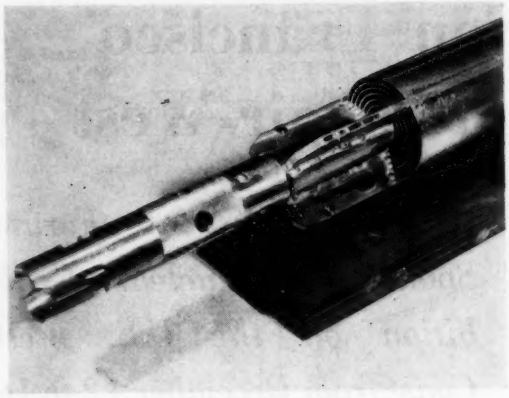
One interesting by-product of the "compacting" of AtomFair-West is the fact that the 70 exhibitors can be said to represent the hard core of the nuclear industry in the United States, with only minor exceptions. Truly active exhibitors in the U.S. nuclear field have never totalled more than 150 in the most active exhibiting year. Some firms admit openly that they would prefer to have nuclear exhibits once every two years—some even say that benefits from show participation are hard to measure—but, even so, the familiar faces turn up time and time again. From this point in time, it seems a certainty that nuclear exhibitions in the U.S. will continue on an annual basis; the Forum is setting its plans up that way, based on a poll conducted earlier this year in which AIF members voted overwhelmingly in favour of the annual affair run by AIF and ANS, in marked preference to the shows staged in conjunction with the Nuclear Congresses each spring. (There will be no Nuclear Congress in 1961 and plans for future events of this type are still indefinite, perhaps reflecting recognition of the industry's stand in favour of AIF-ANS events.)

It might be appropriate to mention at this time another facet of this year's event in San Francisco that gives a clue to attitudes in the U.S. nuclear industry, and that is the portion of the AIF conference devoted to the atom and its relation to space propulsion programmes. Last year "atoms in space" found a spot on the plenary session; this year AIF has added two full panel sessions on the topic. Expanding government-backed programmes seeking atomic answers to space propulsion problems mean exciting business potentials for many companies now finding earthbound A-power business not so profitable. Sprinkled throughout AtomFair-West a visitor will find space plans given heightened emphasis although much of the actual work is in the feasibility and prototype area.

1960 Western Atomic Industry Fair Exhibitors

Advanced Technology Laboratories.
Aerojet-General Nucleonics.
Aeroquip Corporation.
Allis-Chalmers Mfg. Co.
Anton Electronic Laboratories, Inc.
Atom Industry.
Atomic Energy of Canada, Ltd.
Atomics International, Div. of North American Aviation, Inc.
The Babcock & Wilcox Company.
Battelle Memorial Institute.
Bio-Rad Laboratories.
S. Blickman, Inc.
The Brush Beryllium Company.
Central Research Laboratories, Inc.
Charleston Rubber Company.
Combustion Engineering, Inc.
Controlled Atmosphere Enclosures Mfg. Co., Inc.
Corning Glass Works.
Diamond Power Specialty Corp., Sub. of The Babcock & Wilcox Co.
Dublin Industries, Inc.
Eberline Instrument Corporation.
The Edlow Lead Company.
General Astrometals Corporation.
General Atomic Division General Dynamics Corporation.
General Electric Company.
General Mills, Inc.
Hamner Electronics Co., Inc.
The Harshaw Chemical Company.
Harvey Aluminium Co.
Hughes Aircraft Company.
Instron Engineering Corp.
Isotopes Specialties Company, Div. of Nuclear Corp. of America.
Kaman Nuclear.
Knapp Mills, Incorporated.
Kollmorgen Optical Corporation.
The Landsverk Electrometer Co.
Lerma Engineering Corporation.
M. & C. Nuclear, Inc., Texas Instrument Inc. Div.
Mallinckrodt Nuclear Corporation.
Marion Laboratories, Inc.
The Marquardt Corporation.
National Carbon Co., Div. of Union Carbide Corp.
National Lead Company.
Nuclear Data Inc.
Nuclear Engineering Company, Inc.
Nuclear Measurements Corp.
Oak Ridge National Laboratory.
Packard Instrument Company, Inc.
Pacific Coast Engineering Co.
Penberthy Instrument Company.
Permali, Inc.
Pittsburgh Plate Glass Company.
Radiation Counter Laboratories, Inc.
Radiation Instrument Development Lab., Inc.
Ray Proof Corporation.
RCA Service Company.
Reactor Experiments, Inc.
Research Equipment Co.
Riggs Nucleonics Corp.
Spencer Chemical Company.
Sylvania-Corning Nuclear Corporation.
Technical Associates.
Technical Measurement Corp.
Techniques Nucleaires.
Teleflex Incorporated.
Tracerlab, Inc.
Turco Products, Inc.
United Shoe Machinery Corp.
U.S. Atomic Energy Commission.
U.S. Nuclear Corporation.
The Victoreen Instrument Company.
Westinghouse Electric Corporation.

Nuclear Engineering will be the only technical journal participating at AtomFair-West. With the exception of the AIF's *Memo to Members* of the Forum and the ANS *Journal of Nuclear Science and Engineering*, which will be featured in the two organizations' own exhibits, the news periodical *Atom Industry* will mount the only publisher's stand: *Nuclear Engineering* shares the space on a co-operative basis.

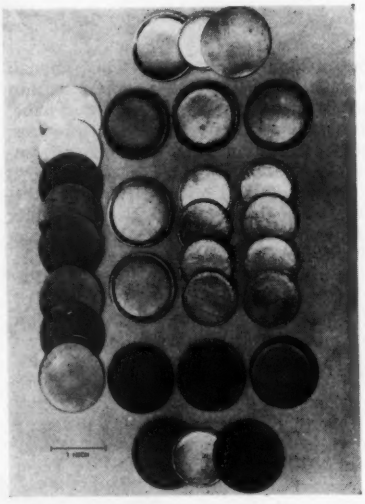


The end fitting and its disconnect on the BR-2 fuel element (*Sylvania-Corning Nuclear Corporation*).

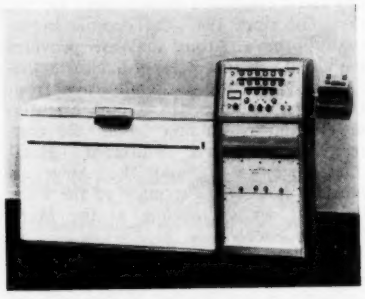
In spite of its compact nature, AtomFair-West mounts a complete array of representative nuclear systems, products, equipment and services, covering not only nuclear power but applications of radiation to industrial processes. One prominent grouping is in the field of "hot lab" equipment; this is due in the main to the presence during the week of members of the ANS Hot Laboratories Division, meeting in conference as part of the ANS Winter Meeting. One of the most unusual devices on display is the "Omniscope," a product of **Lerma Engineering Corporation,** Northampton, Mass. This new concept in periscope and borescope design has not as yet been demonstrated outside the United States; it transmits—without scanning—a 180° true field of view from inaccessible, remote regions and is built in small diameters for lengths up to 40 ft. Its designers claim a 300% increase in field of view over conventional optical instruments.

At least four exhibitors, **Penberthy Instrument, Research Equipment, Corning Glass Works** and **Pittsburgh Plate Glass,** will be showing radiation shielding windows while **Central Research Labs** of Redwing, Minnesota, will display a full line of manipulators and remote handling tools.

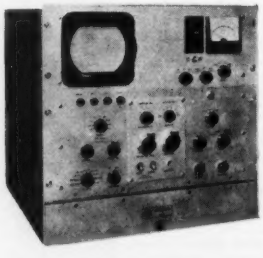
From the major reactor system suppliers there will be the usual array of cutaway models with little pre-show indication that anything new and startling will be unveiled. What seems to be more interesting is a group of exhibitors new to nuclear halls, some of them well-known firms now turning to nuclear pursuits and others who are staking their business future on a fairly narrow range of nuclear products. Most familiar, perhaps, are **Spencer Chemical** and **The Marquardt Corporation.** Spencer is featuring the products of its Nuclear Fuels Department with particular emphasis on uranium and thorium oxides and related compounds. Marquardt, well known in the aviation industry, enters the lists with stress on its current work on propulsion systems for space application and a full list of stated capabilities in power systems and components. Among the lesser-known newcomers are the following: **Bio-Rad Laboratories** of Richmond, California; supplier of stable and radioactive isotopes, labelled compounds and chromatographic materials . . . **Dublin Industries** of Hayward, California; basically an organization devoted to solving problems in environmental control including production of systems for remote processing of radioactive materials . . . **Kaman Nuclear** of Colorado Springs, Colorado; producer of pulsed neutron generators . . . **Permali** of Mt. Pleasant, Pennsylvania; its standard and boron-loaded neutron shielding has



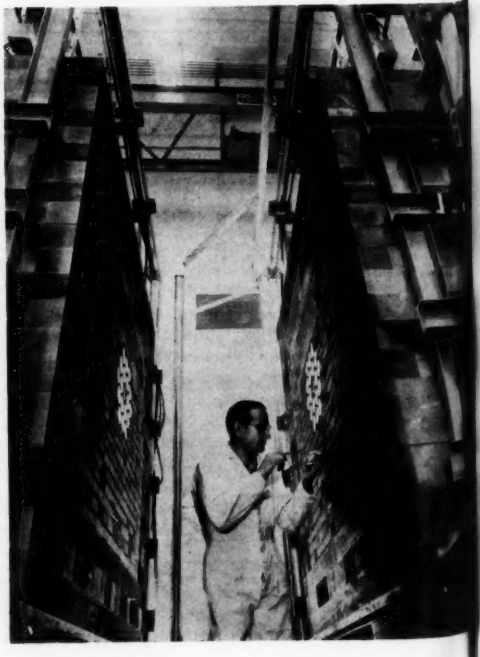
A series of foils for analysing neutron fluxes (*Reactor Experiments, Inc.*).



Tri-carb liquid scintillation spectrometer (*Packard Instrument Co.*).



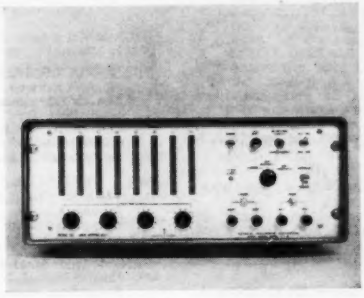
Completely transistorized multi-channel pulse height analyser (*Radiation Instrument Development Laboratory, Inc.*).

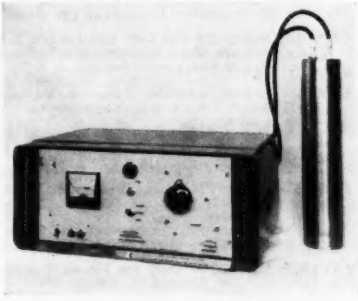


(Right) Low power critical assembly for studying the HTGR system which General Atomic will be actively promoting in S.F.

Low level beta counting system (*Technical Associates*).

(Below) Model 220 data handling unit (*Technical Measurement Corporation*).

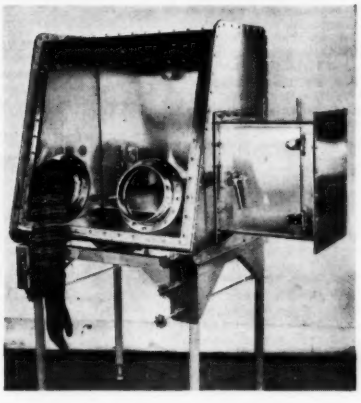




Pulsed neutron generator for reactor pulsing or analytical systems involving neutron activation or thermalization techniques (*Kaman*).

Automatic sample changer. Model ASC-3 can handle gas flow and scintillation counting simultaneously (*Technical Associates*).

Safety enclosure in SS with clear view and sloping front for handling biological, chemical and radioactive materials (*S. Blickman, Inc.*).



already been used in the Marcoule G2 Reactor, at Windscale and in the Fast Breeder Reactor at Dounreay . . . **Reactor Experiments,** San Francisco, California; producer of a neutron gamma irradiation facility for training applications . . . **Teleflex,** North Wales, Pennsylvania; supplier of equipment and instrumentation for in-core flux mapping systems . . . **Riggs Nucleonics;** radiation monitoring systems . . . and **Nuclear Engineering** of Pleasanton, California; specialists in radiation and toxic waste disposal, decontamination and repair services.

One firm is making the long jump from Europe: **Techniques Nucleaires** of Argenteuil, France; its display will feature special purpose stainless steel valves and components, polytetrafluoroethylene measuring and control devices and " gaflon " for gaskets and accessories.

Perhaps the most interesting of the new arrivals is a firm that was virtually born on the doorstep of AtomFair-West, formed less than three months in advance of the exhibition and reflecting an interesting " hands across the sea " operation. The firm is **General Astrometals Corporation** of Yonkers, New York, which was formed for the purpose of producing metals, ceramics and cermets for high temperature and nuclear applications. The company will produce and sell beryllium metal and related products under licence to Pechiney of France, with particular stress on shapes which have heretofore been produced by relatively costly techniques or which have not been available at all. Other Astromet products include burnable poisons for the nuclear industry and other powder metallurgy and ceramic products for industrial applications. Some initial production items will come from France but ultimately most fabrication is planned to be done in the United States.

From this brief preview of AtomFair-West, perhaps some general conclusion might be drawn about exhibit philosophy among American nuclear firms. While some of the major system suppliers may be somewhat lukewarm about the benefits to be derived from nuclear shows (no one has ever written an order for a multi-million dollar reactor on the show floor) it is the intermediate supplier that seems to develop most of the enthusiasm for such events. There he is quite often in contact with a wide range of potential customers, many of them from among his neighbouring exhibitors. That this is true is demonstrated by one exhibitor's suggestion that the show doors be closed for one day just to allow exhibitors time to talk among themselves without interruption. For the smaller firms with limited promotion budgets, the annual shows are often their major effort for the year, in some cases accounting for enough sales to provide a production backlog for many months. Despite conflicting opinions and in spite of the still unresolved situation *vis-à-vis* AIF-ANS AtomFairs and expositions of the Nuclear Congress, it seems a certainty that the U.S. will continue to have its show-a-year for the nuclear industry.

Continental Industries *Review*

1. ADDRESS SECTION

Austria

AUTRO-CHEMATOM KERNBRENNSTOFF Gm.b.H., St. Peter 224, Linz/Donau. Tel.: Linz 2.91.81. T.A.: Austro-Chematom Linzdonau.
Associate Companies: Osterreichische Stickstoffwerke AG, Linz/Donau; Degussa, Frankfurt/Main; The Rio Tinto Management Services (U.K.), Ltd., London.
Fabrication of fuel elements.

BOHLER BROS. AND CO., LTD., Elisabethstr. 14, Vienna 1.
T.A.: Stahlbohler Wien.
Specialist materials.
Austenitic stainless steels with low Co content; sheet, bars, forging and casting, for reactor Kahl (Fa. Mannesmann); austenitic or ferritic steels with boron content for shielding applications (ASEA, Sweden, and various Swiss companies).

SIEMENS-SCHUCKERTWERKE Gm.b.H., Nibelungengasse 11-15, Wien 1. Tel.: 57.16.16. T.A.: Buro Dyn Wien.
Heavy electrical.
Transformer stations with compressed air system, cable laying, alternator, induction motor with oil-cooled starter for energy supply to the Seibersdorf (Vienna) research reactor site (Oesterreichische Studiengesellschaft fur Atomenergie—SGAE); grid plate, grid plugs, mounting plates, etc., for Seibersdorf (AMF—Atomics).

SIMMERING-GRAZ-PAUKER AG, Mariahilferstr. 32, Vienna VII. Tel.: 45.76.61–60. T.A.: Esgepe.
Heavy electrical, boiler manufacture, general fabrication.
Most of the mechanical equipment for swimming pool reactor, ASTRA (Seibersdorf), particularly aluminium welded reactor tank, thermal column, beam tubes, transparent shields, operating platform, remote controlled underwater irradiation device, fully automatic standby diesel aggregate with flywheel; installation of all this equipment (AMF—Atomics and Osterreichische Studiengesellschaft fur Atomenergie); fully automatic standby diesel aggregate with flywheel for Atomic Research Institute Boris Kidric, Belgrade; steel reactor tank, thermal columns, beam tubes, thermal column door aggregate for reactor TRIGA, Atomic Institute of Austrian Universities, Vienna; installation of all this equipment, and pouring of heavy concrete (Holmes Narver (General Atomics) and Ministry of Education, Vienna).

Belgium

A.B.R. (ATELIERS BELGES REUNIS, S.A.), Usines du Brabant, Tirlemont. Tel.: 82555. T.A.: Atelunis Tirlemont.
Boiler manufacture, general fabrication, precision mechanisms.
Oscillating hoist for BR 2 (CEN); condenser and feed water heaters for BR 3 (BEN); overhead travelling crane for BR 2 (CEN); miscellaneous mechanical parts for reactors and nuclear laboratories (tubes, plugs, turning cable for hot cell, flaw test loop, grips, etc.).

ACEC (ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI, S.A.), B.P. 254, Charleroi. Tel.: 07–36.00–20. T.A.: Edempain Charleroi.
Associated Companies: Westinghouse, U.S.A. and Framatome, France, in SENA
Heavy and light electrical, precision mechanisms, instrumentation. Co-sponsors of Ardennes PWR project
Cockroft Walton generator (Ecole Royale Militaire); Cockroft Walton generator (Faculte Polytechnique à Mons); magnet and vacuum equipment for cyclotron (Universite de Louvain); mechanical and control equipment for Van de Graaf accelerator (Universite de Liege); main coils for synchro-cyclotron (CERN); main coils and pole-face windings for proto-synchrotron (CERN); nuclear control equipment for BR 1 and BR 2; pressure vessel, main cooling pumps, auxiliary pumps, nuclear control equipment, emergency power units for BR 2 (all CEN, Mol).

APPLICOM N.V., S.A., 109 Avenue de France, Anvers. Tel.: 32.99.23. T.A.: Applicoma Antwerpen.
Agents for English Electric Co., Ltd.

STE. D'ARENDONK, 29 Avenue Brugmann, Brussels. Tel.: 38.25.27. T.A.: Socarendo Brussels.
Associate Companies: Plasticongo, Sertra, Sertra Congo.
Special materials, various fabrications.
Installation of various tanks with special linings, pipework, pumping relays at CEN, Mol. Pilot plant for preliminary waste; pipe system in hydraulic channel; hot ventilation system; pumping relays between main pipes and in-coming cables; connecting pipes—cold-tepid; installation of tanks for heat-treatment, lining included; lining of temporary hot tanks; piping system between BR 2 and 3; installation of pipe runs for chemical effluents.

AUTOMATIQUE ELECTRIQUE, S.A., Boomgaardstraat 22, Berchem-Antwerp., Tel.: 39–38–00. T.A.: Strowger Antwerp.
Associate Company: General Telephone and Electric Corp.
Light electrical.

USINES BALTEAU, rue de Serbie, 91-97, Liege. Tel.: 52.01.40. T.A.: Balteau Liege.
Associate Companies: Laboratories du Professeur Berthold, Germany; Pantatron, Ltd., England.
Light electrical, instrumentation, specialist materials.
Industrial X-ray equipment, gamma-ray equipment, control and measurement instruments for radiation.

BELCHIM, 35 rue des Colonies, Brussels 1. Tel.: 12.31.50. T.A.: Nucleochim Brussels.
Associate Companies: 23 Belgian companies interested mainly in chemical engineering, non-ferrous metallurgy and civil engineering.
Designing and building nuclear chemical plants.
Solvent-extraction pilot unit(Eurochemic).

BELGONUCLEAIRE, 35 rue des Colonies, Brussels 1. Tel.: 12.31.50. T.A.: Nucleus Brussels.
General fabrication.
Equipment for "Siloe" research reactor, BelgoNucleaire design (Ghent University); nuclear engineering for BR 2 and BR 3 (CEN, Mol); nuclear consultation for reactor (Lovanium University, Leopoldville); all equipment for subcritical assembly (BelgoNucleaire Laboratories).

BELL TELEPHONE MFG. CO., 1 Francis Welles Plaats, Antwerp. Tel.: 57.78.00. T.A.: Microphone Antwerp.
Instrumentation.
Complete reactor control instrumentation, drive mechanisms included, for swimming pool type research reactor, University of Ghent (BelgoNucleaire).

BEN, 47 rue Montoyer, Brussels. Tel.: 13.38.20. T.A.: Belgatome.
Sponsoring Companies: Courtoy, "Ecetra," "Electrobel," "Sofina," Societe de Traction et d'Electricite.
Engineering consultants.
Consulting engineers services, supervision of erection of Belgian Pilot Nuclear Power Plant BR 3 and Belgian MTR BR 2 (CEN); preliminary study for nuclear power plant C.N.S. (Syndicatom); preliminary study, inquiry for bids and tenders comparison for Chooz nuclear centre (Société d'Energie Nucleaire Franco-Belge des Ardennes—SENA).

CHAUDRONNERIES PIERRE BROUHON, S.A., 39 bis, rue de la Station, Awans-Bierset. Tel.: 63.46.21. T.A.: Brouhon Bierset.
Boiler manufacture, general fabrication.

CARNOY-VANDENSTEEN, S.A., 56 Bd. du Petit Dock, Ghent. Tel.: 09/23.24.81. T.A.: Carnoy-Vandensteen.
General fabrication.
Stainless steel, carbon steel and aluminium steel auxiliary piping, for reactor BR 3 (CEN, Mol); stainless steel waste piping for BR 3; stainless steel waste piping for HF reactor BR 2 (CEN, Mol).

CFE, 33 rue de l'Industrie, Brussels 4. Tel.: 12.51.50. T.A.: Secondaire Brussels.
Civil engineering.
Civil engineering for nuclear reactors BR 1, BR 2, BR 3, in conjunction with S.A. Auxeltra Genie civil (CEN, Mol).

CITAR, S.A., 162-164 Quai des Usines, Brussels 2. Tel.: Brussels 16.81.30. T.A.: Citartub Brussels.
Specialist materials, piping.
Carbon steel, aluminium for BR 2, stainless steel, alloy steel and plastic for BR 3 (CEN, Mol).

COCKERILL-OUGREE, S.A., Seraing. Tel.: Liege 34.08.10. T.A.: Cockerill-Ougree.
Boiler manufacture, general fabrication, specialist materials.
Containers and piping.

CONTIGEA, S.A., 140 rue de Stalle, Brussels 18. Tel.: 02/44.48.53. T.A.: Comtegea Brussels.
Instrumentation.

ETS. DEGREMONT, 1 Quai des Vennes, Liege. Tel.: 43.40.15. T.A.: Sovetreaux Liege.
Associate Company: Ets. Degremont-Acfi, France.
Specialist materials.
Waste treatment plant, purification on primary pool and experimental loops for test reactor (CEN, Mol); waste treatment plant for test reactor (SGAE, Vienna).

ATELIERS DE CONSTRUCTION D'HONDT, S.A., 112 rue Bara, Brussels 7. Tel.: 21.00.76. T.A.: Dhondtcuivre Brussels.
Boiler manufacture.
Stainless steel lining of discharge canal, carbon steel waste tanks, for BR 3 reactor (CEN, Mol); carbon steel mixed bed demineralizers, aluminium reactor seal pressure accumulator, aluminium valve actuator, pressure accumulator for BR 2 reactor (CEN, Mol).

ELECTRO APPAREILS, S.A., 233 rue de la Loi, Brussels. Tel.: 33.99.73. T.A.: Electrap.
Associate Company: Cie Industrielle de Bruleurs a Mazout.
Instrumentation, specialist materials.
Installation of automatic heating and air conditioning regulation (CEN, Mol).

ELECTRONIC ASSOCIATES, INC., 43 rue de la Science, Brussels. Tel.: 11.43.69.
Associate Companies: Electronic Associates, Inc.; Electronic Associates, Ltd. Manufacturers of PACE computers.

ATELIERS DE CONSTRUCTIONS D'ENSIVAL, S.A., Pepinster. Tel.: 087/60166. T.A.: Construction Pepinster.
Specialist materials.
Pumps for BR 2 and BR 3, Eurochemic (CEN, Mol).

EVENCE COPPEE ET CIE, 103 Bd. de Waterloo, Brussels 1. Tel.: 38.60.30. T.A.: Evence Coppee Brussels.
Associate Companies: Société d'Etude et de Construction Evence Coppée (ECEC); Compagnie Graver; Mécanique Automatique Moderne.
Pilot plant for absorption of radioactive gaseous iod., incinerator for radioactive waste and fumes purification installation (CEN, Mol); cooling plant for swimming pool reactor (BelgoNucleaire); general layout and civil engineering of a swimming pool reactor plant (Ministere des Travaux Publics).

Belgium *(contd.)*

FABRICOM, 28 Galerie Ravenstein, 7 Cantersteen, Brussels 1. Tel.: 11.23.15. T.A.: Fabricom Brussels.
Associate Company: Electrobel, S.A.
Light and heavy electrical, boiler manufacture.
Cable laying, intake and outlet ducts for cooling air, hot filter building for BR 1; switchboard, supply and erection of safety-valve discharge-tank, and of metallic tanks for pit and waste drain cell, erection of primary pipework in aluminium alloy, primary circuit exchangers and tank in aluminium alloy; supply and erection of pipework in light alloy (inox and aluminium for reactors), for BR 2. Supply and erection of two exchangers for auxiliary cooling circuits, buffer tanks in copper for auxiliary cooling system, main pipework for secondary-circuit water and steam for BR 3 (for CEN, Mol).

HAMON, S.A., 58 rue Capouillet, Brussels 6. Tel.: 37.12.90. T.A.: Achamon Brussels.
Associate Companies: Sobelco, Brussels; Hamon, Paris; Hamon, Inc., Chicago; Spig, Milan; Esindus, Madrid; Favra, Buenos Aires; Precom-primido, Caracas.
Cooling plant for water circuit (forced air) for BR 2 reactor (CEN, Mol); similar installations for EL3 pile, Saclay, and Pu plant, Marcoule (CEA).

ATELIERS J. HANREZ, S.A., Monceau-sur-Sambre. Tel.: Charleroi 07/314400. T.A.: Hanrez Marchienne au Pont.
Associate Company: Hanrez et Cie, Paris.
General fabrication, precision mechanisms.
Rubber seat butterfly valves for BR 2 reactor (Sofina, Brussels); control rod mechanisms for research reactor, Ghent University (Belgonucleaire).

USINES EMILE HENRICOT, S.A., Court-St.-Etienne. Tel.: 010/622.05. T.A.: Henricot Court-St.-Etienne.
General fabrication.
Cast steel, carbon and stainless steel forged parts for BR 2 reactor (Mol).

SOCIETE GENERALE METALLURGIQUE DE HOBOKEN, Hoboken (Antwerp). Tel.: 03/38.58.80. T.A.: Metaux Anvers.
Associate Companies: Union Minière du Haut-Katanga; Métallurgie et Mécanique Nucléaires; Societe Générale des Minerais.
Preparation of nuclear grade U, metal and oxides, cast in vacuum (L'Union Minière du Haut-Katanga).

HYDROBEL, S.A., 98 Quai Vercour, Sclessin-Liege. Tel.: 04/52.21.20. T.A.: Hydrobel Liege.
General fabrication, precision mechanisms.

ATELIERS DE CONSTRUCTION DE JAMBES-NAMUR, 16 rue de la Gare, Jambes. Tel.: 081/313.55. T.A.: Jamur Jambes.
General fabrication.
Structural steel (CEN, Mol).

NOUVEAUX ATELIERS LEBRUN, S.A., rue Mouzin, Nimy. Tel.: 065/351.57. T.A.: Lebrun Nimy.
Boiler manufacture, general fabrication, specialist materials.
73 stainless steel beam-ports, air and gas compressors, heat exchangers for BR 2 (CEN, Mol).

LEFEVRE FRERES S.A., 111 rue Paul Pastur, Ransart (Hainaut). Tel.: 07/350642. T.A.: Lefevre Freres Ransart.
General fabrication and boiler manufacture, steel plate pressing. Propane storage installation, all tanks for chemical process and nuclear plant (CEN, Mol).

MBLE., 80 rue des Deux-Gares, Brussels 7. Tel.: 21.82.00. T.A.: Mazda Brussels.
Instrumentation.
Complete radiation monitoring and health physics instrumentation for BR 2 (CEN, Mol).

MERCANTILE MARINE ENGINEERING AND GRAVING DOCKS CO. S.A., Hansadock, 403, Antwerp. Tel.: 41.04.20. T.A.: Shafting Antwerp.
Associate Companies: C.F.E., Brussels; L'Electro-Navale et Industrielle, Aartselaar.
General fabrication and installation.
Neutron shield tank, stainless steel lining, connection between storage well and transfer tank, installation of 12 MW turbine for BR 3 (CEN, Mol); supply and erection of various pressure vessels and piping for BR 2 (CEN, Mol); irradiation channel and structural steelwork for experimental reactor, Ghent University (Belgonucleaire, Brussels); general facilities and shielded medical survey room (CEN, Mol).

METALLURGIE ET MECANIQUE NUCLEAIRES, rue Voie de Liege, 33 a 39, Herstal. Tel.: Liege 64.08.00. T.A.: Numetal Herstal.
Associate Companies: Hoboken; Fabrique Nationale d'Armes de Guerre; Ateliers de Constructions Electriques de Charleroi; Union Minière du Haut-Katanga.
Core manufacture.
5 tonnes U slugs (CEN); 2.3 tonnes U slugs (Japanese Atomic Energy Research Institute) 1 tonne clad U slugs (Union Minière du Haut-Katanga); core for swimming pool reactor (UO_2) (Belgonucleaire).

ETS. NEU, 190 Chaussee de Bruxelles, Tournai. Tel.: 210.61. T.A.: Etneu Tournai.
Specialist materials.
"Grisbi" room air cleaner for radioactive laboratories, including an absolute filter (CEN, Mol); ventilation plant for BR 2 and 3 (CEN, Mol).

COMPAGNIE DES METAUX D'OVERPELT-LOMMEL ET DE CORPHALIE S.A., 54 rue de Fabriques, Brussels 1. Tel.: 12.31.30. T.A.: Overcor Brussels.
Effluent: sulphate of alumina for water purification (CEN, Mol); lead shielding blocks, lead sheets for shielding for Geneva (CERN); cadmium; ingots, sticks, rods, for Marcoule, Saclay (CEA).

PHENIX WORKS S.A., Flemalle-Haute, Pce. de Liege. Tel.: 04/337819. T.A.: Borgal Liege.
General fabrication, specialist materials.

PHYSIQUE INDUSTRIELLE S.A., 66 Bd. de l'Imperatrice, Brussels 1. Tel.: 11.28.54. T.A.: Nucleonics Brussels.
Subsidiary of: Tracerlab, Inc., U.S.A.
Instrumentation.
Automatic shakers, ratemeters, G.M. tubes, portable survey meter for CEN, Mol, universities, industry.

SERAI, 1091 Chaussee d'Alsemberg, Brussels 18. Tel.: 44.19.15. T.A.: Setreda Brussels.
Research and development, precision mechanisms, instrumentation, specialist materials.
Experimental loops.

SOBECOMIN S.A., 20 rue du Luxembourg, Brussels 4. Tel.: 13.19.44. T.A.: Sobecomin, Brussels.
Associate Companies: Scoriethom, Brussels; Procongo S.C.R.L., Brussels; Parcotube, Brussels.
Valves and pipes (CEN, Mol).

SOBELCO S.A., 58 rue Capouillet, Brussels 6. Tel.: 37.12.90. T.A.: Sobelco Brussels.
Associate Companies: Hamon, Brussels; Hamon, Paris.
General fabrication, specialist materials.
BR 3, Mol-condenser-preheater for a Westinghouse turbine; equipment for injection of reagents in the secondary circuit; equipment for the treatment and demineralization of radioactive effluent for a research reactor at Ghent; four condensers and a preheater unit for a Westinghouse turbine, equipment for injection of reagents in the water of the secondary circuit for BR 3, Mol; treatment of the radioactive effluent, demineralization for research reactor, Ghent.

STEGU S.A., 4 Quai de Willebroeck, Brussels. Tel.: 17.02.27. T.A.: Steguts Brussels.
Associate Companies: Regu S.A., Paris; Ronald Trist and Co., Ltd., Slough.
Ancillary equipment for boilers, comprehensive equipment for checking liquid levels in tanks, precision mechanisms; installation of magnetic contactors for the checking of water levels in various parts of BR 2 and 3, Mol; magnetic contactors—Stegu-Mobrey (check of levels) for BR 2: for transfer tanks of effluents and condensates in connection with the cooling water tower of the ancillary equipment and the sump tanks of underground installations I and II (43 altogether); BR 3: for II emergency systems of the radioactive waste disposal system (19 altogether); BR 3: for checking of the level in the demineralized water tank of the primary circuit (2 altogether); BR 2: for the cooling water basins, the well, the hot and tepid channels, and the tank at the top of the preheater of the pressurizing system (9 in all).

TOLERIES GANTOISES S.A., 177 Chaussee de Tronchienne, Gand. Tel.: 03/26.19.70. T.A.: Inox Gand.
Piping for BR 2 (CEN, Mol).

ACCUMULATEURS TUDOR S.A., Florival (Brabant). Tel.: Wavre 010/841.01. T.A.: Tudor Florival.
Light electrical.
Lead acid and alkaline batteries (CEN, Mol).

SOCIETE DES MINES ET FONDERIES DE ZINC DE LA VIELLE MONTAGNE S.A., Angleur, near Liege. Tel.: 65.38.00. T.A.: Vieilmont Angleur.
General fabrication.
Lead for shielding, antimonial lead bricks, lead sheets and dust, lead containers, zinc bromide, all for CEN.

ETS. WANSON S.A., Avenue de la Woluwe, Haren-Brussels 13. Tel.: 20.08.00. T.A.: Wanson Brussels.
Associate Companies: Ets. Wanson, Arcueil (Seine); Ets. Parent, Nerac (L. and G.).
Boiler manufacture.
Supply of two hot water boilers, Marcoule.

Denmark

BURMEISTER AND WAIN'S MASKIN—og SKIBSBYGGERI, Strandgade 4, Copenhagen K. Tel.: Asta 2501. T.A.: Burmeisters.
Shipbuilders, general fabricating.
Aluminium tank and heavy steel top shield for reactor DR 3, Risø (Pluto type) (Danish Atomic Energy Commission).

ELSINORE SHIPBUILDING AND ENGINEERING CO., LTD., Helsingor.
Boiler manufacture, general fabrication.
Containment, flasks for fuel handling, compressor for distillation plant for contaminated water for DR 3; turbine-driven helium circulator for OEEC DRAGON Project.

A. S. FRICHS, Aarhus. Tel.: Aarhus 061/58555. T.A.: Frichs Aarhus.
General fabrication.
Various reactor components, load-unload flask for DR 3 Risø (Danish Atomic Energy Commission).

A. S. HASLE KLINKER AND CHAMOTTSTENSFABRIK, 6 Osterbrogade, Copenhagen O. Tel.: Central 254. T.A.: Hasleklinker.
Specialist materials.

THOMAS B. THRIGE, Odense.
Electric and electro-mechanical equipment for industrial and scientific use (especially apparatus, machinery, transformers).

France

L'AIR LIQUIDE, 75 Quai d'Orsay, Paris 7e. Tel.: Inv. 44.30. T.A.: Airliquid Paris.
Associate Companies: Compagnie Française de l'Eau Lourde; Sté. d'Etude pour l'Obtention du Deuterium; Sté. des Tres Basses Températures; Soudure Autogene Française; Spirotechnique.
Specialist materials.
Helium purification system for EL 2 and EL 3 (CEA, Saclay); carbon dioxide purification system, G2 and G3 (Marcoule Nuclear Centre, CEA); CO_2 purification system EDF 1 and 2 (EDF nuclear power station, Chinon); deuterium production plant for hydrogen distillation plant, Toulouse (Cie Française de l'Eau Lourde); hydrogen liquefaction station for Saturne proton synchrotrons, etc., Saclay (CEA); tanks, piping, welder parts, mechanical devices, etc., for U plant, Malvery, etc. (CEA subsidiary); cryogenic equipment (loops, liquefiers, etc.), respiratory masks, etc., for Saclay and Grenoble nuclear centres (CEA).

SACM, STE. ALSACIENNE DE CONSTRUCTION MECANIQUES, 32 rue de Lisbonne, Paris, 6e. Tel.: Por. 89.39. T.A.: Alsatelec Paris.
General fabrication, precision mechanisms, instrumentation.
Fuel elements, loading and unloading devices, control rods, containers, flux measurements, burst slug detection, control system, civil engineering, general architecture for G2 and 3 reactors, Marcoule (CEA and EDF).

ALSTHOM, STE. DE CONSTRUCTIONS ELECTRIQUES ET MECANIQUES 38 Avenue Kleber, Paris 16e. Tel.: Passy 01.50. T.A.: Alsthom Paris.
Associate Companies: SACM; Cie Française Thomson-Houston; Rhenameca; Sobemo; Unimap; Ezpi; Sermiar; Altulor; Dieselair; Delas; Neypic; etc.
Heavy and light electrical, boiler manufacture.
All electrical equipment (supply, control, operation) for Marcoule reactors G1, 2 and 3 (CEA); "Saturne" synchrotron for Saclay (CEA); turbo-alternator sets for reactors EDF 1 and 2, Chinon (EDF); electric air preheater for reactor G1, Marcoule (CEA); test rigs for research on cooling for reactors EL 3, Saclay, and G1, 2 and 3, Marcoule (CEA); control cinetics for G2 and 3 (CEA).

STE. APPLEVAGE, 78 rue Vitruve, Paris 20e. Tel.: Roquette 95.50. T.A.: Applevage Paris.
Specialist materials.
Two 300-ton Goliath cranes, one for Hunterston power station (GEC, Erith).

STE. GENERALE D'APPLICATIONS ELECTROTHERMIQUES, 24 rue de Mendon, Boulogne (Seine). Tel.: Molitor 65.60. T.A.: Applectherm.
Heavy electrical.
Vacuum U melting furnaces for SICN and CERCA; degassing furnaces for U rods for SICN.

France *(Contd.)*

CHANTIER DE L'ATLANTIQUE (PENHOET-LOIRE), 7 rue Auber, Paris 9e. Tel.: Richelieu 93.70. T.A.: Shipyard Paris.
Associate Company: GAAA.
Ship building, boiler manufacture and general fabrication.
Pile EL 3 (CEA); pile PEG (CEA); storage and purification of CO_2 for G2 and 3 (CEA); heat exchangers for EDF 2, Chinon (co-contractor with Babcock, Compagnie des Surchauffeurs and Fives-Lille; EDF); various components for Rapsodie, EDF, etc. (EDF and CEA).

COMPAGNIE EUROPEENNE D'AUTOMATISME ELECTRONIQUE, 8 rue Lavoisier, Paris 8. Tel.: Eur 32.05. T.A.: Autelec Paris.
Associate Companies: CSF; Intertechnique; Thompson Ramo Wooldridge, Inc.
Instrumentation and control systems.
Two RW–300 digital control computers (EDF, Chinon).

STE. FRANCAISE DES CONSTRUCTIONS BABCOCK AND WILCOX, 48 rue La Boetie, Paris 8e. Tel.: Ely. 89.50. T.A.: Babcock Paris.
Boiler manufacture, general fabrication.
Heat exchangers for Marcoule G1 and 2, Chinon EDF 2 (EDF); mechanisms, high grade steel components for Saclay (CEA); equipment for Uranium gaseous diffusion plant of the CEA.

ETS. J. BODSON AND FILS, 14 bis, rue Denis Papin, Puteaux (Seine). Tel.: Longchamp 09.37.
Precision mechanisms, instrumentation.
Endoscopes and periscopes for Saclay, Grenoble, Fontenay-aux-Roses (CEN); and for Pu plant, Marcoule.

BREVATOME, 25 rue de Ponthieu, Paris 8e. Tel.: Bal 17.80.
Patent exploitation and protection group.

BRISSONNEAU AND LOTZ, 8 rue Bellini, Paris 16e. Tel.: Passy 35.79. T.A.: Etabris Paris.

CECA, CARBONISATION ET CHARBONS ACTIFS, 24 rue Murillo, Paris 8e. Tel.: Carnot 82.00. T.A.: Carbacti Paris.
Associate Company: Groupement des Industries Atomiques, Paris.
Specialist materials, chemical engineering.
Drying, oil elimination in pressurized CO_2 circuits for reactors G1, 2 and 3, Marcoule (CEA); air elimination in D_2O circuits, Saclay (CEA); elimination of nitrous vapours in tanks for thorium ore preparations, for Sté. Potasse et Engrais Chimiques, Paris.

ETS. S. R. CLAVE, 9 rue Olivier Metra, Paris 20e. Tel.: Pyrenees 05.10.
Precision mechanisms, specialist materials.
Supply of optical equipment (periscopes, TV camera heads, mirrors, lenses, viewing windows, etc.) for high temperatures to CEA, EDF and various university laboratories.

CICAF, COMPAGNIE INDUSTRIELLE DES COMBUSTIBLES ATOMIQUES FRITTES, Domaine de Corbeville, Par Orsay (S. and O.). Tel.: 928.53.35. T.A.: Cicaf Orsay.
UO_2 fuel elements (CEA).

COCEI, COMPAGNIE CENTRALE D'ETUDES INDUSTRIELLES, 127 rue de Saussure, Paris 17e. Tel.: Mac-Mahon 52.50.
Associate Companies: L'Electro-Entreprise; Sté. Comsip-Automation.
Design of control and instrumentation for EDF 1 and 2, Chinon (EDF); also for gaseous diffusion plant (CEA); design of electrical installation for Pégase (CEA); design of burst slug detection equipment for EDF 2, Chinon (EDF).

COMMISSION DE L'INSTRUMENTATION NUCLEAIRE FRANCAISE, Constructors Association, 23 rue de Lubeck, Paris 16e. Tel.: Passy 01.16. T.A.: Fnielectronique Paris.
Instrumentation.

COMPRESSEURS A MEMBRANE CORBLIN, 78-80 Bd. Saint-Marcel, Paris 5. Tel.: Port-Royal 35.19. T.A.: Corblin Paris.
Specialist materials.
Diaphragm compressors and pumps for Risley, Dounreay, Windscale, Harwell; Fraser, John Brown, de Havilland; AEC U.S.A., General Electric; AEC Canada; CEA, Saclay, Grenoble, Marcoule.

CDC, COMPAGNIE DES COMPTEURS, 12 Place des Etats-Unis, Montrouge (Seine). Tel.: Ale. 58.70. T.A.: Comptelux Montrouge.
Associate Companies: Constructions Radioélectriques et Electroniques du Centre; Controle et Regulation.
Light electrical, precision mechanisms, instrumentation, specialist materials.
Instrumentation and control design for reactors Pegase and Ulysse (CEA); instrumentation and control for swimming pool reactor Melusine, Grenoble (CEA); control rod drives supply and erection for EDF 1 reactor, Chinon (EDF); radioactive airdust monitors—monitoring of sites for CEA.

CONSTRUCTIONS RADIOELECTRIQUES ET ELECTRONIQUES DU CENTRE, 19 rue Daguerre, St. Etienne (Loire). Tel.: 32.39.77. T.A.: Circe St. Etienne.
Instrumentation.
Radioactive airdust monitor, permanent alpha monitor (CEA).

CONTROLE BAILEY, 32 Bd. Henri IV, Paris 4e. Tel.: Tur. 35.78. T.A.: Baileytrol Paris.
Instrumentation.
Instrumentation and control for reactors G2 and 3, Marcoule (CEA and EDF) and for reactors EDF 1 and 2 (EDF).

SFAC, STE. DES FORGES ET ATELIERS DU CREUSOT, 15 rue Pasquier, Paris 8e. Tel.: Anjou 3440. T.A.: Forgeac.
Boiler manufacture, general fabrication, precision mechanisms, specialist materials.
Pressure vessel: internal and large gas pipes for reactors G1, 2 and 3 (CEA); nuclear graphite machine tools, Marcoule (CEA); loading and unloading gear for EL 3 reactor (CEA); loading and unloading gear for EDF 1 and 3 (EDF); stainless steel tight vessel and closures for Rapsodie (CEA); high permeability steel magnets for Paris and Lyon Universities, CERN Synchro-cyclotron (CERN); vacuum chamber for Saturne (CEA).

DYNATOM, Paris.
Subsidiary of: Atomics International, U.S.A., SACM and Chantier de l'Atlantique.

L'ELECTRONIQUE APPLIQUE, 25 rue du Docteur Finlay, Paris 15e. Tel.: Alesia 45.20. T.A.: Lelapli Paris.
Associate Company: La Ceramique Ferro-électrique, Paris.
Instrumentation, specialist materials.
Nuclear instrumentation for Saclay (CEA), Chinon (EDF) and Ispra.

FONDERIE DE GENTILLY, 56 rue Raymond-Lefevre, Gentilly (Seine). Tel.: Ale. 18.55.
All forms of radiation shielding.

FRAMATOME, SOCIETE FRANCO-AMERICAINE DE CONSTRUCTION ATOMIQUE, 36 Quai Nationale, Puteaux (Seine). Tel.: Longchamp 22.35.
Associated Companies: Westinghouse, U.S.A.; ACEC, Belgium.
Reactor design and contracting.
Member of SENA which is to construct the Ardennes PWR.

STE. FRANCAISE DE L'ELECTRO-RESISTANCE, 115 bd. de la Madeleine, Nice (A.-M.). Tel.: 618.90. T.A.: Sferom Nice.
Light electrical.
High quality resistors and potentiometers; various electrical circuits for CEA installations.

FRANCE-ATOME, 6 et 8 Bd. Haussmann, Paris 9e.
Group of 22 companies; reactor design and ship studies.
Took part in the construction of the G1, 2 and 3 reactors at Marcoule and the EL 3 reactor at Saclay.

GAMMA INDUSTRIE, 52 rue de Dunkerque, Paris 9e. Tel.: Trudaine 83.82. T.A.: Wellward Paris.
Gamma radiographic equipment for EDF 2 (EDF) and an electro-magnetic isotope separator (University of Paris, Orsay).

GAAA, GROUPEMENT ATOMIQUE ALSACIENNE ATLANTIQUE, 100 av. Edouard Herriot, Le Plessis-Robinson (Seine). Tel.: Robinson 53.44.
Associate Companies: SACM; Chantiers de L'Atlantique.
Boiler manufacture, general fabrication, precision mechanisms, instrumentation.
Architect engineer of the fast neutron breeder, Rapsodie, also supplier of Na loops for the reactor (CEA).

HISPANO-SUIZA, rue du Capitaine Guynemer, Bois-Colombes (Seine). Tel.: Charlebourg 38.80. T.A.: Hispanoto Paris.
General fabrication.
Mechanical neutron spectrometer (CEA); charge and discharge mechanism for EDF 1, Chinon (EDF).

INDATOM, 48 rue La Boetie, Paris 8e. Tel.: BAL 83.40. T.A.: Indatom Paris.
Reactor designers and manufacturers.

CITRA, COMPAGNIE INDUSTRIELLE DE TRAVAUX (SCHNEIDER), 16 Bd. Malesherbes, Paris 8e. Tel.: Anjou 34.40. T.A.: Citravaux Paris.
Civil engineering for EL 3 reactor, Saclay; G1, 2 and 3 reactors, Marcoule; Pu extraction plant. (All CEA.)

INTERTECHNIQUE, 81 rue Escudier, Boulogne-Billancourt (Seine). Tel.: Molitor 83.20. T.A.: Intertec.
Instrumentation.
Multi-channel analysers, neutron time of flight analysers (CEA); burst slug detectors and associated computing and control apparatus for EDF 1 and 2 reactors (EDF).

JEUMONT, 5 Place de Rio-de-Janeiro, Paris 8e. Tel.: Carnot 08.60. T.A.: Jeumontelec Paris.
Member of Framatome (SFAC; Schneider Westinghouse; Merlin & Gerin, etc.).
Heavy and light electrical, general fabrication, specialist materials.
Special electro-magnets for synchrotron Saturne, Saclay (CEA); special electric motors for D_2O pumps, CO_2 emergency circulators, etc., for Saclay and Marcoule (CEA); bubble chambers.

ETS. JOUAN, 113 bd. St. Germain, Paris 6e. Tel.: Odeon 91.46. T.A.: Batechim Paris.
Agents for E. K. Cole and Dynatron.
Electronic and instrumentation equipment, electrical supply stabilizers, high tension supply units to particle detectors, glove boxes and counting equipment, etc.

ETS. KUHLMANN, 25 bd. de l'Amiral Bruix, Paris 16e. Tel.: Kleber 50.50. T.A.: Etakuhlm Paris.
Specialist materials.
Uranium plants for L'Ecarpiere and Bessines (Sté. Industrielle des Minerais de l'Ouest-Kuhlmann and CEA), for Le Forez (CEA) and Mounana (Compagnie des Mines d'Uranium de Franceville); various nuclear installations for CEA.

CIE LYONNAISE DE GENIE CHIMIQUE P. LACOLLONGE, 50/54 cours de la Republique, Villeurbanne (Rhone). Tel.: 84.83.68. T.A.: Ebonitage Lyon.
Associate Companies: Lacollonge, Flexone; also affiliated companies and foreign licencees.
Specialist materials, chemical engineering.
Pipework, tanks, special containers, protection of equipment used in ore preparation, for CEA and SIMO.

ETS. A. LIBBRECHT, 39 rue de l'Epeule, Roubaix (Nord France). Tel.: 73.31.00. T.A.: Inox Roubaix.
Boiler manufacture for CEA.

CAFL, COMPAGNIE DES ATELIERS ET FORGES DE LA LOIRE, 12 rue de la Rochefoucauld, Paris 9e. Tel.: Trinite 81.50. T.A.: Forgaloire Paris.
Boiler manufacture, general fabrication, precision mechanisms and specialist materials.
Mechanical equipment and heat exchangers for power and swimming pool reactors (CEA); mechanical and boiler welding supplies, valves and piping for crushing and refining plant (CEA, Mines), for Pu plant (CEA, Marcoule) and for isotopic separation of heavy water (CEA, Toulouse); control rods and drives for swimming pool reactors (CEA); fuel handling units (now under construction) for power reactors (EDF 2, Chinon); special steel for nuclear industry, shielding steel, containers and equipment for experimental reactors.

STE. DES CHANTIERS REUNIS LOIRE-NORMANDIE, 7 rue Auber, Paris 9e. Tel.: Ric. 93.70. T.A.: Chantloire Paris.
Boiler manufacture, general fabrication.
Engineering framework parts, cast-iron shields, tangential channels of the pile block, metallic bridges; erection of the pile block and bridges; service truck for ionization channels; cast-iron doors, roofs and walls of laboratories for active products, for EL 3 reactor, Saclay (CEA); CO_2 storage tanks G2 and 3 reactors, Marcoule (CEA); casing presses for nuclear fuel for Saclay and Noisy-le-Sec factory (CEA and Comptoir Lyon-Allemand); graphite stacking for EDF 2, Chinon (EDF).

LORRAINE-ESCAUT, 7 Rond Point Bugeaud, Paris 16e. Tel.: Pas. 35.36. T.A.: Lorenesco Paris.
Iron and steel products, welded and seamless steel tubes.
Steel plates, special tubing for pressure vessels, heat-exchangers, etc., for EDF 1 and 2, Chinon, CEA (Cie Française d'Entreprises, Cie des Surchauffeurs, Ets. Levivire, COMSIP); special piping for burst slug detection equipment; reinforcement wire for pre-stressed concrete, for G2 and 3, Marcoule (CITRA).

LUMPP AND CO., 12 rue Jouffroy d'Abbans, Lyon 5e, Rhone. Tel.: 83.75.28. T.A.: Lumpp Lyon.
Specialist materials.
Laboratory and chemical engineering equipment, vacuum and acid pumps, special valves for acids and vacuum conditions and air compressors.

MECI, S.A.—MATERIEL ELECTRIQUE ET DE CONTROLE INDUSTRIEL, 123 bd. de Grenelle, Paris 15e. Tel.: Fontenoy 90.00. T.A.: Mecivocem Paris.
Instrumentation.
Control and regulation units for laboratories, various piles, separation and extraction plant (CEA, Marcoule, Saclay, Euratom; CEN in Jugoslavia).

France (Contd.)

FORGES ET CHANTIERS DE LA MEDITERRANEE, 6 et 8 rue Camou, Paris 7e. Tel.: Sol. 99.99. T.A.: Vasco Paris.
Associate Companies: Auxi-Atome and Sud-Atome, Paris.
Boiler manufacture, general fabrication, precision mechanisms.

METAFRAM—LA METALLURGIE FRANCAISE DES POUDRES, 56 rue de Londres, Paris 8e. Tel.: Europe 26.70. T.A.: Metaframem.
Associate Companies: Trefileries et Laminoirs du Havre; Cie Française des Métaux; Banque de l'Union Européenne (groupe Schneider); Cie Generale du Duralumin et du Cuivre; Cie Electro-Mecanique.
Specialist materials.
Control rods for Melusine, Minerve, Triton (CEA); and for EDF 1 and 2 (EDF); stainless filters for Melusine, Minerve, Triton, EL 3, Rapsodie.

STE. D'ELECTRICITE MORS, 11 rue Petit a Clichy (Seine). Tel.: Pereire 54.70. T.A.: Telemors Clichy-La-Garenne.
Heavy and light electrical, general fabrication, specialist materials.
Control panels for cyclotrons and synchrotrons (CEA, Saclay); electrical equipment for handling systems (EL 3, Saclay); safety and radiation control equipment (particle accelerators, etc., CEA).

ETS. NEU S.A., 47 rue Fourier, Lille (Nord). Tel.: 57.10.56. T.A.: Etneu Lille.
Specialist materials.
CO_2 fans and blowers, " Grisbi " room air cleaner for radioactive laboratories, including an absolute filter (CEA); air conditioning and ventilation plant for Pu works, laboratories and F.E. decanning plant, Marcoule (CEA); fluorine cooling for Narbonne (CEA).

ETS. NEYRPIC, Avenue de Beauvert, Grenoble. Tel.: 44.55.30. T.A.: Neyrpic Grenoble.
General fabrications.
Design and manufacture of equipment for Mélusine, Grenoble; design and manufacture of treble gate valves for G2 and 3 reactors, Marcoule.

OERLIKON S.A., 15 rue de Milan, Paris 9e. Tel.: Trinité 28.61. T.A.: Oerlik Paris.

OPTIQUE ET PRECISION DE LEVALLOIS, 106 rue Chaptal, Levallois (Seine). Tel.: Per. 79.40. T.A.: Precioptic.
Precision mechanisms.
Microscope for remote observation and for use in glove boxes (CEA, Saclay).

SOM, STE. D'OPTIQUE ET DE MECANIQUE DE HAUTE PRECISION, 125 bd. Davout, Paris 20e. Tel.: Roquette 81–85. T.A.: Sombertios Paris.
Optical apparatus; hydraulic control mechanisms.

PECHINEY, 23 rue Balzac, Paris 8e. Tel.: Carnot 54.72. T.A.: Pechiney Paris.
Specialist materials.
Nuclear graphite for French reactors (CEA); Be for U.K. AEA; BeO_2 for French research reactors (CEA).

STE. DES ACIERIES DE POMPEY, 61 rue de Monceau, Paris 8e. Tel.: Laborde 97.10. T.A.: Pompeac Paris.
Special steel manufacturers.
Suppliers to nuclear construction companies; connections with Saclay.

QUARTZ AND SILICE, 8 rue d'Anjou, Paris 8e. Tel.: Anjou 17.36. T.A.: Siliquartz Paris.
Instrumentation; all phosphors for scintillation counting of radiation.
Scintillators for all official organizations in the nuclear field, and for all manufacturers of nuclear instruments.

LA RADIOTECHNIQUE, 130 avenue Ledru Rollin, Paris 11e. Tel.: Voltaire 18.50. T.A.: Tubelec Paris.
Instrumentation.
Photomultipliers, scintillators, all other special electronic valves and semiconductors.

STE. RATEAU, 141 rue Rateau, La Courneuve (Seine). Tel.: Flandre 18.80. T.A.: Turmachi La Courneuve.
General fabrication.
Main and auxiliary blowers for reactors G1, 2 and 3, Marcoule (CEA); special circulators for EL 2 and 3, Saclay and G2 and 3, Marcoule, isotopic separation plant (CEA); canned motor pumps for EL 3, Saclay and marine propulsion (CEA and French Navy); main steam tubines for reactors G1, 2 and 3, Marcoule (EDF); isolating and regulating valves for G1, 2 and 3 (CEA); special solenoid valves for reactor G3, Marcoule and reactor EDF 1, Chinon (CEA and EDF); hydraulically operated valves for marine propulsion (French Navy); test loops for Saclay (CEA).

ENTREPRISE RAZEL FRERES, 17 rue de Tolbiac, Paris 13e. Tel.: Port-Royal 45.59. T.A.: Razelfrer Paris.
Civil engineering.
Excavations at Chinon nuclear centre; general management of the site for the isotopic separation plant at Pierrelatte (Drôme).

RIBET-DESJARDINS, 13 rue Perier, Montrouge (Seine). Tel.: Ale. 24.40. T.A.: Pilacelect.
Instrumentation.
High performance oscilloscopes for Saclay, Fontenay, Marcoule, Grenoble (CEA); also Ispra (Euratom).

ROCHAR ELECTRONIQUE, 51 rue Racine, Montrouge (Seine). Tel.: Alesia 00.03.
Instrumentation.
Flowmeters, digital systems, electronic counters.

SAINT-GOBAIN, SERVICES NUCLEAIRES, 23 bd. Georges Clemenceau, Courbevoie (Seine). Tel.: Mer. 10.00. T.A.: Atogobain Neuilly.
Associate Companies: SETU, CERCA, INDATOM, SRU, CLAA.
General fabrication, precision mechanisms, instrumentation, specialist materials.
Chemical reprocessing plant, decanning plant, installation for storage of fission products, cells for Marcoule; plant for nuclear grade U refining, Narbonne; fabrication of fuel elements, Bonneuil-sur-Marne; laboratory hot cells, Saclay (all CEA); effluent treatment and waste disposal plant for Chinon (EDF); hot cells for Karlsruhe (KBB); chemical reprocessing plant for Mol (Eurochemic); special instruments for hot laboratories for various establishments.

SAIP, STE. D'APPLICATION INDUSTRIELLES DE LA PHYSIQUE, 38 rue Gabriel-Crie, Malakoff (Seine). Tel.: Alesia 87.20. T.A.: Saiphy Malakoff.
Instrumentation.
Nuclear instruments for CEA, Euratom, CERN, etc.

SAMES, 21 rue Jean-Mace, Grenoble (Isere). Tel.: 44.77.64. T.A.: Electrostatic Grenoble.
Manufacturers of accelerators for nuclear research.

STE. DE CONSTRUCTION D'UNE USINE DE SEPARATION ISOTOPIQUE, 104 avenue Edouard-Herriot, Le Plessis-Robinson (Seine). Tel.: Robinson 56.20.
Associate Companies: Ugine; TSF; SACM; Heurtey, S.A.; SFAC; Sté. Rateau.
Construction of an isotopic separation plant.

SEPI, EXPLOITATION DE PRODUITS INDUSTRIELS, 4 rue de Londres, Paris 9e. Tel.: Pigalle 69.19. T.A.: Tequip Paris.
General fabrication, precision mechanisms, instrumentation, specialist materials.
Expansion joints for CO_2 cooling system and piping for reactors G1, 2 and 3, Marcoule (CEA); instrumentation and thermodynamic control for Chinon (EDF).

SFIM, STE. DE FABRICATION D'INSTRUMENTS, Avenue M. Ramolfo-Garnier, Massy (S. and O.). Tel.: 928.10.90. T.A.: Sfim Massy.
Associate Company: SFIM, Slough.
Instrumentation.
Pressure transducers for various installations (CEA and EDF).

SICN, STE. INDUSTRIELLE DE COMBUSTIBLE NUCLEAIRE, 69 rue de Monceau, Paris 8e. Tel.: Laborde 60.50.
Specialist materials.
Fuel elements for reactors EL 2, G1, 2 and 3; contracted for EDF 1 and 2, also special elements for Rapsodie.

SIERSATOM, 108 av. du Maine, Paris 14e. Tel.: Segur 23.09. T.A.: Robispe Paris.
General fabrication, precision mechanisms, instrumentation, specialist materials.
Lead shields, casks, protection apparatus (gamma ray, X-ray); glove boxes, irradiation devices, ventilation hoods, master-slave manipulator, radioactive rod and waste disposal installation, universal decanning machine; autoclaves for sterilization; tungsten-molybdenum furnaces; arc furnaces, sodium purifier; diffusion columns; cutting-off machine; polishing machine; tensile test apparatus; densimeters, X-ray diffraction apparatus.

SNECMA, STE. NATIONALE D'ETUDE ET DE CONSTRUCTION DE MOTEURS D'AVIATION, Division Atomique, 22 Quai Gallieni a Suresnes (Seine). Tel.: Longchamp 28.70. T.A.: Motavia Paris.
Boiler manufacture, general fabrication, precision mechanisms, instrumentation, specialist materials.

SOCEMA, STE. ELECTRO-MECANIQUE, 37 rue du Rocher, Paris 8e. Tel.: Laborde 79.60. T.A.: Megacem Paris.
Associate Company: Indatom.
Heavy and light electrical, general fabrication, precision mechanisms.
CO_2 turbo-blower for reactor EL 2, Saclay, D_2O–H_2O heat exchanger and CO_2 test rig for EL 3, Saclay; irradiated fuel laboratory, Saclay; electrical supply to magnets of the particle accelerator, Saturne, Saclay (all CEA); CO_2 circulators for Chinon (EDF); supply coils for controlled fusion (CEA).

SODERN, S.A., STE. D'ETUDES ET DE REALISATIONS NUCLEAIRES, 10 rue de la Passerelle, Suresnes (Seine). Tel.: Lon. 15.81. T.A.: Sodern Paris.
Associate Companies: La Radiotechnique, S.A.; TRT; LEP.
Instrumentation.
Mineral insulated sheathed thermocouple cables for reactors G1, 2 and 3, Marcoule (CEA); for reactor EDF 1, Chinon (EDF); for laboratories and plant, U.K. AEA (U.K. distributor: Research and Control Instruments Ltd.); for various AEC laboratories (American representative: Amperex Electronic Corp.).

SOGREAH, 84/86 av. Leon Blum, Grenoble (Isere). Tel.: 44.55.30. T.A.: Sogreah Grenoble.
Associate Company: Neyrpic Group.
Research and design, test rigs and model tests, consultant engineering.
Test loops for H_2O, D_2O, CO_2, terphenyl (in-pile or out of pile) study for CEA reactors and laboratories; fluid circuits design (fluid mechanics, thermodynamics, heat transfer, etc.) for CEA; exchangers, burst slug detection equipment for reactors Mélusine, Triton, EL 3, (CEA); research on separation processes, waste disposal installation, handling of irradiated fuel elements and uranium ores.

SRAT, STE. DE RECHERCHES ET D'APPLICATIONS TECHNIQUES, 41 rue Emeriau, Paris 8e. Tel.: Vau. 79.33. T.A.: Rechaplitec.
Instrumentation.
Portable decontaminators and detectors, for CEA, Defence Nationale, establishments, mining companies and laboratories.

SRTI, STE. DE RECHERCHES TECHNIQUES ET INDUSTRIELLES, 111 rue La Boetie, Paris 8e. Tel.: Balzac 54.55.
Instrumentation, specialist materials.
Design and construction for the gaseous diffusion plant (uranium enrichment) for CEA; also pressure and flow measurements, corrosion study, superficial treatment.

STEAFIX AND CIE, 17 rue Francoeur, Paris 18e. Tel.: Ornano 59.89. T.A.: Steafix Paris.
Associate Company: CSF, Paris.

STEIN AND ROUBAIX, 24 rue Erlanger, Paris 16e. Tel.: Jasmin 94.40. T.A.: Steinrou Paris.
Boiler manufacture.
Complete liquid metal cooling system for nuclear research centre, Fontenay-aux-Roses (CEA); complete pressurized gas cooling system for EDF 1 and 2, Chinon (EDF).

TECHNIQUES NUCLEAIRES, 82 rue de Montigny, Argenteuil (S. and O.). Tel.: 961.19.93.
Associate Company: Appareils Gachot.
Instrumentation, specialist materials.
Stainless steel valves for Chatillon, Saclay, Marcoule, Grenoble (CEA); special valves for EDF 1, Chinon (EDF); instrumentation and control equipment for Ugine, Pierre Benite, etc.

CIE FRANCAISE THOMSON-HOUSTON, Division Nucleaire, 173 bd. Haussmann, Paris 8e. Tel.: Ely 83.70. T.A.: Elihu Paris.
Light electrical, instrumentation.
Control and monitoring for EL 3 reactor, Saclay (CEA); equipment for Minerve, Fontenay-aux-Roses (CEA); transfer-phasemeter for EL 3, Saclay (CEA); RF units for synchrotron Linac at Geneva (CERN); and for Brookhaven (U.S.A.); tightness-test by helium " sweating " for fuel-rod plant of Annecy (SICN) and Saclay and Marcoule (CEA); various TV systems for Saclay, Marcoule, Fontenay-aux-Roses, Grenoble (CEA); servo-positioning unit of lower loading arm for EDF 1 reactor, Chinon (EDF).

CSF, CIE GENERALE DE TSF, 79 bd. Haussmann, Paris 8e. Tel.: Anjou 84.60. T.A.: Telonde Paris.
Associate Companies: ANALAC; CICE; CICAF; CEAE; CERE; CAMECA.
Light electrical, precision mechanisms, instrumentation, specialist materials.
Particle accelerators for Saclay and Orsay (CEA and Ecole Normale Supérieure); nuclear grade Zr for Saclay (CEA); reactor control computer and data handling unit for Chinon (EDF); nuclear instruments for Saclay and civil defence system (CEA and Ministère de l'interieur); special ceramics (CEA); watertight pumps for Saclay, EL 3 (CEA); remote handling unit for Marcoule (CEA).

France (Contd.)

TUNIZI, S.A., 90 rue Cardinet, Paris 17e. Tel.: Mac-Mahon 12.95.
General fabrication.
Air conditioning and ventilation for proton-synchrotron (CERN, Geneva); air conditioning of the control rooms of reactors G1, 2 and 3, Marcoule (CEA); ventilation and air conditioning for various laboratories and special industries (Saclay, Marcoule, Gadrache, CEA).

MARC VERNAY, INGENIEUR CONSTR., 19 rue Louis Ducroize, Villeurbanne, Rhone. Tel.: Lyon 84.91.17. T.A.: Mervay Lyon.
Specialist materials.
Rotary drum continuous filters and thickeners for CEA.

STE. D'UGINE, 10 rue du General-Foy, Paris 8e. Tel.: Europe 31.00. T.A.: Trochim Paris.
Associate Companies: Cefilac, Ugine-Carbone, Savoie-Acheson, Sté. des Résines Fluorées, SICN, France-Atome.
Specialist materials.
UF_6 production, Zr, special nuclear steel, Al-Mg, Na-Co, sintered metal filters, magnets, measurement apparatus, glove-boxes, fluorined products and resins, chlorined and oxygenated products.

Germany

AEG (ALLGEMEIN ELEKTRICITATS-GESELLSCHAFT), Frankfurt (Main) Sud-10. Tel.: Frankfurt (Main) 60521. T.A.: Elektronkea.
Associate Companies: Telefunken GmbH, Berlin; Olympia Werke AG, Wilhelmshaven; Hydrawerk AG, Berlin.
Heavy and light electrical and instrumentation.
Complete turn-key nuclear power station for Kahl/Main (15 MW(e) BWR-indirect cycle, natural circulation), together with U.S. General Electric and Hochtief for Versuchsatomkraftwerk Kahl GmbH (Rheinisch-Westfälisches Elektrizitätswerk und Bayernwerk); planning and construction of the research reactors Merlin and DIDO and associated installations, together with Ruhrstahl AG for Atomforschungszentrum Jülich des Landes Nordrhein-Westfalen; supply of a 50 MeV-deuteron-isochronous-cyclotron for Gesellschaft für Kernforschung, Karlsruhe; complete instrumentation for the DIDO reactor for Atomforschungszentrum Jülich; reactor simulator for Technische Hochschule Darmstadt.

AGROB, AG FUR GROB-UND FEINKERAMIK, Ehrang/b. Trier. Tel.: 6046/47/48/49. T.A.: Agrob Ehrang.
Specialist materials.

CARL AMBROSIUS, Hauptstr. 19, Eisen/Saar. Tel.: Türkismühle/Saar 227. T.A.: Manganerz Türkismühle/Saar.
Barytes for heavy aggregate for radiation shielding.

ANTITRON-GESELLSCHAFT FUR STRAHLENSCHUTZ mbH, Dortmund-Mengede, Castroperstr. 43. Tel.: 1.33.52.

ATLAS-WERKE AG, Bremen, Woltmershauserstr. 442/444. Tel.: 5.57.57. T.A.: Atlaswerke.
Instrumentation.
Mass spectrometers and gas detectors to many companies in Germany and abroad.

DEUTSCHE BABCOCK AND WILCOX—DAMPFKESSELWERKE AG, Oberhausen (Rhld.) Duisburgerstr. 375. Tel.: 24521. T.A.: Babcockwerke Oberhausen.
Boiler manufacture, specialist materials, general fabrication.
Heat exchangers for D_2O, spent fuel element storage ponds including gates, auxiliary equipment for Kernreaktor Bau-und Betriebs GmbH, Karlsruhe; layout and design of 5 MW swimming pool reactor in co-operation with B. and W. Co., New York, for Gesellschaft für Kernenergieverwertung in Schiffahrt und Schiffbau, Hamburg; including irradiation chamber and necessary test facilities, primary and secondary cooling circuits, radioactive water treatment plant, concrete shield walls for Land Nordrhein-Westfalen, Düsseldorf for material-testing reactor DIDO; storage block, experimental facilities, lead shielding test-rigs for heat transfer test on heat exchanger surfaces and reactor fuel elements for Gesellschaft zur Förderung der Kernphysikalischen Forschung e.V., Aachen.

MASCHINENBAU-AG BALCKE, (21b) Bochum. Tel.: Bochum 6.90.11. T.A.: Balckemaschinen Bochum.
Associate Company: Maschinenbau-AG Balcke, Frankenthal.
Boiler manufacture.
Mechanical draught cooling tower for Gesellschaft für Kernenergieverwertung in Schiffahrt und Schiffbau m.b.H., Hamburg; heat exchangers for AEG für Atomkraftwerk Kahl/Main; air and thermal plant for Kernreaktor Bau und Betriebsgesellschaft m.b.H., Karlsruhe/Baden.

AB BBC-KRUPP, Dusseldorf, Konigsallee 70 I. Tel.: Düsseldorf 83841. T.A.: Arge BBC-Krupp.
Associate Companies: Brown, Boveri and Cie AG, Mannheim Fried. Krupp, Essen.
Reactor design; Pebble-bed reactor.

LAB. PROF. DR. BERTHOLD, Wildbad im Schwarzwald, Calmbacherstr. 22. Tel.: Wildbad 587. T.A.: Labe Wildbad.
Instrumentation.
Hand and foot monitor for Kernreaktor GmbH, Karlsruhe; air monitoring system, laboratory counting equipment for Atomforschungszentrum, Jülich.

BOPP AND REUTHER GmbH, Mannheim, Waldhof, Carl Reutherstr. 1. Tel.: 58091. T.A.: Bopreuther.
Valves and butterfly valves for D_2O circuit, helium-circuit, air-circuit for Kernreaktor Bau-und Betriebs-GmbH, Karlsruhe i., Baden; valves and butterfly valves for D_2O circuit, helium-circuit, air-circuit for reactor MERLIN (ordered by Government of district Nordrhein-Westfalen); valves and butterfly valves for D_2O circuit, helium-circuit, air-circuit for reactor DIDO (ordered by Government of district Nordrhein-Westfalen).

BORSIG AG, Berlin-Tegel, Berliner Str. 19-37, Westsektor. Tel. 45.60.11. T.A.: Borsig Berlintegel.
Boiler manufacture, general fabrication, precision mechanisms.
Steam plant compressors for Hahn-Meitner-Institut für Kernforschung.

BRINDI, LTD., Munchen 23, Ohmstr. 9. Tel.: 36.35.56. T.A.: Brindi Munchen.
Radiation measuring equipment for Reaktor Jülich, Reaktor Karlsruhe, Reaktor Munchen.

BUCHLER AND CO., Braunschweig, Frankfurterstr. 294. Tel.: 2.53.15. T.A.: Herbuchler.
Instrumentation.
Neutron sources, iridium radiation apparatus; safes, transport containers; shielded set for plating on table; shielded table; lead bricks, glove boxes; remote handling tongs; tele-instruments; ball manipulators; pipettes, burettes; injection devices, shielding against beta rays.

CEAG (CONCORDIA ELEKTRIZITATS AG), Dortmund, Munsterstr. 231. Tel.: 8.86.11. T.A.: CEAG Dortmund.
Air filters and dust collectors.
Air filters for intake and exhaust air, power reactor Kahl/Main, and Krantz-Lufttechnik, Aachen; air filters for intake and exhaust air, research reactor Seibersdorf, near Vienna, and Inges-Klimatechnik, Wien; air filters for intake and exhaust air, research reactor Prater, Vienna II, and Small and Cie, Wien; air filters for intake and exhaust air for diverse isotope laboratories, and air conditioning firms.

CSF (COMPAGNIE GENERALE DE TELEGRAPHIE SANS FIL), Direktion Deutschland, Munchen 15, Goethestr. 10. Tel.: 531607. T.A.: Tesafi Munchen.
Associated Company: Compagnie Européenne d'Automatisme Electronique, 8 rue Laboisier, Paris 8e.
Instrumentation, specialist materials.
Equipment for power reactors and isotope separation plants of CEA.

DELBAG-LUFTFILTER GmbH, Berlin-Halensee, Schweidnitzerstr. 11-16. Tel.: 97.76.76. T.A.: Delbagfilter Berlin.
Associated Company: Delbag Air Filters, Ltd., Arundel Road Trading Estate, Uxbridge, Middx.
Specialist materials.
Air filters for separation of air-borne and radioactive dust in the air entering and leaving plants in which radioactive materials are used.

DEMAG-ZUG GmbH, Wetter-Ruhr. Tel.: Wetter 2041. T.A.: Demagzug Wetteruhr.
Associate Company: Interatom.

DINGLERWERKE AG, Zweibrucken. Tel.: 34.51. T.A.: Dingler Zweibrücken.
Boiler and general fabrications, precision mechanisms, instrumentation, specialist materials.
Reactor building, biological shield, assembly of the reactor, for Kernreaktor Karlsruhe.

DONGES STAHLBAU GmbH, (16) Darmstadt, Mainzerstr. 55, Postschliessfach 449. Tel.: 7.4331. T.A.: Donges Stahlbau Darmstadt.
Associate Company: Donges Stahltor-und Fensterbau GmbH, Darmstadt, Mainzerstr. 55.
Containment vessel and circular travelling crane for research reactor at Frankfurt (Universitätsbauamt Frankfurt), and reactors Merlin and DIDO, Jülich (AEG, Rhurstahl); hot bearing with co-ordinate crane for Farbwerke Höchst, Frankfurt (Atom Research Centre); exhaust air chimney for Versuchsatomkraftwerk Kahl (AEG, Frankfurt).

DRAEGER, HEINR. AND BERNH. DRAEGER, Moislinger Allee 53-55, Lubeck. Tel.: 25831. T.A.: Draegerwerk Lubeck.
Respiratory protection, pressure gas armatures, medical apparatus, regulators for air-conditioning, filtration units for air purification. Micro-filters with casings exchangeable by manipulator.

DURRWERKE AG, Ratingen (Rhld.). Tel.: Ratingen 3611. T.A.: Dürrwerke.
Boiler manufacture.
Heat exchangers.

EDWARDS HOCHVAKUUM GmbH, Frankfurt (Main)-Niederrad, Hahnstr. 34. Tel.: 673343. T.A.: Edwardsvakuum ffm.
High vacuum equipment for the following: Gesellschaft fur Kernphysikalische Forschung Aachen, Bonn und Düsseldorf, Arbeitsgemeinschaft BBC-Krupp; Kernreaktor GmbH Karlsruhe, International Atomic Energy Agency, Wien; Versuchsatomkraftwerk, Kahl.

ELEKTROPHYSIK DR. STEPHAN, Bad Godesberg, Plittersdorferstr. 72. Tel.: 6.88.44. T.A.: Elektrophysik Badgodesberg.
Monitor instrumentation for radioactive gases, aerosols and effluents inside and outside reactor buildings.

ELEKTROSCHMELZWERK KEMPTEN GmbH, Munchen 22, Bruderstr. 10. Tel.: 22.99.91. T.A.: Elektroschmelze.
Specialist materials.
Boron carbide.

ESCHER WYSS GmbH, Ravensburg/Wurttbg., Postfach 105. Tel.: 4401 Ravensburg. T.A.: Escherwyss Ravensburg.
Associate Company: Escher Wyss AG, Zurich.
Heat engines; steam and gas turbines, turbo compressors and blowers; vaporization plants.

FERNSTEUERGERATE OHG ZACHARIA-OELSCH-MEIER, Berlin-Britz, Jahnstr. 68-72. Tel.: 62.04.51. T.A.: Telemeter.
Precision mechanisms, instrumentation.

P. FISCHER AND CO. AG, Frankfurt/Main, Holbeinstr. 48. Tel.: 61051. T.A.: Röhrenfischer Frankfurt/Main.

FRANK AND SCHULTE HANDELSGESELLSCHAFT mbH, Essen, Ruhr, Alfredstr. 152. Tel.: 4.40.01. T.A.: Silizium.
Specialist materials.
Ferro-alloys, ores, minerals, chemicals, rare earth magnetite, ilmenite, hamatite, limonite, barytes, ironshots, ferrophosphorous, special iron-aggregates, shielding blocks of any size for FRF, Frankfurt, BER, Berlin, FR2, Karlsruhe, DIDO and Merlin Jülich, TRIGA, Vienna, hot cells, Munich.

FRIESEKE AND HOEPFNER GmbH, Erlanger-Bruck, Tennenloherstr. 41. Tel.: 25.51. T.A.: Frieseke Erlangen.
Instrumentation.

DR. ING. FRANK FRUNGEL GmbH, 400 Sulldorfer Landstr., Hamburg-Rissen. Tel.: 81.21.51. T.A.: Fruengel.
Light electrical, instrumentation.
High frequency flashers for high speed photographs of bubble or fog chambers for particle research at Energie Atomique Saclay; 2,000 joule heavy duty flash lamps, step-front electrical shockwave generators, generators and pulse-transformers for big magnetic field erection (up to 500,000 Gauss) for deflections of beams (accelerators) and nucleonic spectroscopy in course of development.

F. J. GATTYS, Frankfurt/Main, Vilbelerstr. 36. Tel.: 27957. T.A.: Gattys Frankfurt/M.
Instrumentation.
Shielding windows, non-destructive testing for Kernreactor Karlsruhe; transport containers, decontamination plants for Reaktor Ffm., Bonn University, etc.

GEA (GESELLSCHAFT FUR LUFKONDENSATION mbH), Bochum, Konigsallee 45-47. Tel.: 6.22.51. T.A.: Luftkühler Bochum.

GFKF (GESELLSCHAFT ZUR FORDERUNG DER KERNPHYSIKALISCHEN FORSCHUNG eV), Dusseldorf, Cecilien-Allee 41/41a. Tel.: 43.41.46. T.A.: Atomcentr. Dusseldorf.
Nuclear research, two reactors (Merlin, DIDO) to research institutes.

Germany *(Contd.)*

TH. GOLDSCHMIDT AG, Essen 1, Postschliessefach 17, Sollingstr. 120. Tel.: 2.12.31 (from Jan. 1961: 20.16.1). T.A.: Stannum Essen.
Specialist materials.
Europium oxide, samarium oxide (not necessarily converted to metal; may be used directly after cladding or as cermets) for control rods.

GRAETZ-RAYTRONIK GmbH, Altena (Westfalen), Graetzstr. Tel.: Altena 821. T.A.: Graetzerk Altenawestf.
Instrumentation.
Count-rate meters supplied to a number of development and research laboratories, and for many commercial applications.

GRUN AND BILFINGER AG, Mannheim, Carl-Reiss-Platz 1-5. Tel.: 45.91. T.A.: Gruenbilf.
Associated Companies: Hüser and Co. Betonwerk GmbH, Oberkassel b., Bonn; Grunbilf de Venezuela, Apartado 3967, Caracas, Venezuela; Grunbilf do Brasil, Caixa Postal 780, São Paulo, Brasilien.
Concrete blocks for radiation protection for the Institut fur Allgem. Metallkunde und Metallphysik der Rhein.-Westf.-Technischen Hochschule in Aachen.

GUTEHOFFNUNGSHUTTE STERKRADE AG, Werk Sterkrade, Oberhausen-Sterkrade. Tel.: Oberhausen 60141. T.A.: Hoffnungshütte Oberhausen-rheinlsterkrade.
Boiler manufacture, general fabrication.
Thermal shield for FR 2 reactor, Karlsruhe (Kernreaktor Bau- und Betriebs-GmbH); steam plant for Kernkraftwerk Kahl (AEG).

REAKTORPUMPEN HALBERG-WEISE AG, Heidelberg, Treitschkestr. 3. Tel.: 2.43.23. T.A.: Arge Heidelberg.
Pump manufacture.

HARTMANN AND BRAUN, Mess und Regeltechnik, Frankfurt/Main-West 13, Grafstr. 97. Tel.: 77.06.11. T.A.: Hartmannbraun Frankfurtmain.
Associated Companies: Schoppe and Faeser GmbH, Minden/Westf.; ELIMA GmbH, Frankfurt/Main; H. and B.-Pneumatik GmbH, Werk Bester, Stuttgart; KIREM GmbH, Frankfurt/Main.
Light electrical, precision mechanisms, instrumentation.
Measurement and control monitors for Reaktor, Frankfurt/Main; measurement and control system for test circuits (Gesellschaft f. Kernenergieverwertung i Schiffbau u. Schiffahrt, Geesthacht, and Interatom, Bernsberg); measurement and control devices for experimental plant for Berlin Technical University; computer work.

W. C. HERAEUS, Hanau. Tel.: 24251. T.A.: Heraeus Hanau.
Zircaloy 2 for R3 Reactor, Sweden, to A.B. Atomenergie; reactor tanks for reactors DIDO and Merlin to Jülich; fuel loading and unloading system for BBC-Krupp pebble-bed reactor to Jülich, AVR; ring-torus for nuclear fusion (Professor Heisenberg, Munchen); vacuum metallurgical installations for several centres for nuclear energy and research.

HERFURTH GmbH, Hamburg-Altona, Beerenweg 6-8. Tel.: 89.33.63. T.A.: Herfurthphysik.
Light electrical, instrumentation.
Radiation indicators for hot laboratories; radiation measuring instruments for reactor stations; radiation monitors for industrial companies.

HILGER AND WATTS, LTD., Dortmund-Horde, Seydlitzstr. 38. Tel.: 4.08.71. T.A.: Hilgerwatts Dortmund-Horde.
Associate Company: Hilger and Watts, Ltd., London, N.W.1.

HOCHTIEF AG, HOCH-UND TIEFBAUTEN, vorm Gebr. HELFMANN, Essen, Rellinghauserstr. 55/57. Tel. 2.01.21. T.A.: Hochtiefessen.

HONEYWELL GmbH, Frankfurt/Main, Rheingaualiee 112. Tel.: 77.07.81. T.A.: Minnreg Frankfurtmain.

INDUSTRIE-WERKE KARLSRUHE AG, Karlsruhe, Gartenstr. 71. Tel.: Karlsruhe 2.29.11. T.A.: Iweka Karlsruhe.
Specialist materials.
Main ducting bellows for G.E.C. (Hunterston); 5 ft expansion joints for A.E.I.-John Thompson (Berkeley); 5 ft 6 in. and 6 ft expansion joints for English Electric-Babcock and Wilcox (Hinkley Point); also special bellows for EDF 2, France.

INTERATOM (INTERNATIONALE ATOMREAKTORBAU GmbH), Altes Schloss, Bensberg/Koln. Tel.: 2.29.76. T.A.: Interatom Bensberg.
Development, design and installation of power reactors for power stations and ship propulsion and the sale of research reactors developed by American parent company, Atomics International.

ISOTOPENLAB. DR. SAUERWEIN, Dusseldorf-Eller, Harffstr. 148. Tel.: 78.62.16.
Associate Company: Isotopenforschung Dr. Sauerwein GmbH, Gemeinnutziges Institut, Dusseldorf-Eller.
Material testing of reactor elements; tracer experiments for reactor DIDO, Jülich and Nordrhein-Westfalen.

JENAER GLASWERK SCHOTT AND GEN., Mainz/Rh., Hattenbergstr. 10. Tel.: 81.61. T.A.: Glaswerk Mainz.
Specialist materials.
Radiation shielding windows for Gesellschaft für Kernenergieverwertung, Hamburg (für Anlage Geesthact), Reaktor Garching, bei Munchen, Kernreaktor Bau- und Betriebs-GmbH, Karlsruhe, and Isotopenlabor d. Farbwerke Höchst, Frankfurt/Main-Höchst (all four delivered to Hans Walischmiller for further installation); also to the Australian Atomic Energy Commission, and Research Centre SORIN, Saluggia, Milan.

GEWERKSHAFT KERAMCHEMIE, Siershahn/Westerwald. Tel.: 254 Ransbach. T.A.: Keramchemie Siershahn.
Associate Companies: Fa. Osterreichische Saurebau-und Korrosionsschutz-Gesellschaft mbH, Haid/Ansfelden bei Linz; Ga. Pracesa, Madrid 8.
Specialist materials.
Acid resisting linings in cooling towers and battery rooms for Kernreaktor Karlsruhe/Leopoldschafen to ARGE Reaktorgebaude Leopoldschafen; plastic linings in storing pits for effluents from isotope laboratories to Dr. Karl Thomae GmbH, Biberach/Risse; plastic linings in test rooms to Max Planck Institut für Biophysik, Frankfurt/M.

KERNREAKTOR BAU- UND BETRIEBS GmbH, Karlsruhe, Weberstr. 5. Tel.: 26825. T.A.: Reaktor Karlsruhe.

AG FUR KERNTECHNIK, Koln-Bayenthal, Bonnerstr. 504.
Associate Companies: Lurgi Gesellschaft mbH, Frankfurt/Main, Gervinusstr.; Leybold Hochvakuum Anlagan GmbH, Köln-Bayenthal, Bonnerstr. 504; Friedrich Uhde GmbH, Dortmund, Deggingstr. 10/12.

KIREM, KERNSTRAHLUNGS, IMPULS UND REAKTOR MESSTECHNIK GmbH, Frankfurt (Main), Baselerstr. 27. Tel. 3304.21. T.A.: Kirem Frankfurtmain.
Instrumentation.

KLOCKNER-HUMBOLDT-DEUTZ AG, Werk Humboldt, Koeln-Kalk. Tel.: 6771. T.A.: Humboldt.
General fabrication.
Sluices for reactor to Kernreaktor Bau-u. Betriebs GmbH, Karlsruhe.

KLOCKNER-WERKE AG, Duisburg, Mulheimerstr. 50. Tel.: 3901. T.A.: Klöcknerwerke.
Boiler manufacture.

KLOCKNER-WERKE AG, Georgsmarienwerke, Osnabruck. Tel.: Osnabruck 3.2.2.1. T.A.: Kloecknergmw.
General fabrication, heavy forgings.

AUG. KLONNE, Dortmund, Westfalendamm 72. Tel.: 2.53.51. T.A.: Klonne Dortmund.
Associate Companies: Schamottwerke Klönne GmbH; Klönne-Collin GmbH.
Boiler manufacture, general fabrication.

ING. ALBERT KNOTT, Munchen 23, Muffatstr. 8. Tel.: Munchen 33.14.80. T.A.: Knottelektronik München.
Instrumentation.

KOHLENSCHEIDUNGS GmbH, Stuttgart-W., Johannesstr. 41-45. Tel.: 6.81.56. T.A.: Unicarbo Stuttgart.
Associate Company: Combustion Engineering, Inc., New York.
Boiler manufacture.

H. KRANTZ LUFTTECHNIK, Aachen, Richterich. Tel.: 36044. T.A.: Krantzklima Aachen.
Specialist materials.
Air conditioning, air heating, ventilating plants to Kernreaktor Bau-und Betriebs-Gesellschaft mbH, Karlsruhe; Forschungsreaktor DIDO, Jülich; RWE Leistungsreaktor, Kahl.

KROPFMUHL-RINGSDORFF AG FUR SONDERGRAPHITE, Bad Godesberg-Mehlem, Konigswintererstr. 1. Tel.: Bad Godesberg 1.20.01. T.A.: Kohlebürste Badgodesberg.
Graphite for all nuclear and reactor engineering purposes such as moderators, reflectors, thermal piles, exponential arrangements, cladding materials (e.g., for fuel elements), components for the manufacture of atomic fuels; speciality: reactor graphite of highest density (up to 2.1 g/cm³).

F. LAMDENDORF, Hamburg 39, Muhlenkamp 59. Tel.: 273442. T.A.: Chempump Hamburg.
Associate Company: Chempump Division Fostoria Corporation, Philadelphia, U.S.A.
Canned motor pumps for handling: D_2O for Reaktor AG, Zurich; diphenyl for Reaktor Bau-und Betriebs GmbH, Karlsruhe; terphenyl for A/B Atomenergie, Stockholm; H_2O at 250°C for Noratom A/B, Halden.

ERNST LEITZ GmbH, Wetzlar/Lahn. Tel.: 851. T.A.: Leitz Wetzlar.
Monocrystals, tracer and metallurgical microscopes, binocular prismatic magnifying glasses; stereoscopic binocular microscopes; ultra microtomes; film camera with attachment for technical and scientific photographs.

LEWA, HERBERT OTT KG, Leonberg b. Stuttgart, Eltingerstr. 58-60. Tel.: Leonberg 7241. T.A.: Lewa Leonbergwuertt.
Precision mechanisms.
Proportioning pump with reversible feed for reactor at AB Atomenergi, Studsvik, Sweden. Projected: adjustable pulsators for regeneration of nuclear waste disposal (OEEC, European Nuclear Energy Agency, Mol); proportioning pumps for CERN, Meyrin-Geneva; and for Kernraktorbau-Betriebs-GmbH, Karlsruhe.

GESELLSCHAFT FUR LINDE'S EISMASCHINEN AG, Zweigniederlassung Hollreigelskreuth b. Munchen. Tel.: München 79.35.81. T.A.: Sauerstoff Muenchen.
Associate Companies: Abt. Grosskalteanlagen, Wiesbaden Machinenfabrik Sürth, Sürth b. Köln, Kühlmöbelwerk Mainz-Kostheim, Guldner-Motoren-Werke, Aschaffenburg.
Helium, protective gas-cleaning plant for DIDO (Kultusministerium Nordrhein-Westf.); helium-cooling and shielding gas cleaning plant for high temperature experimental power reactor of AG BBC-Krupp (Wirtschaftsministerium Nordrhein-Westf.); helium-cleaning plant, model for the high temperature reactor DRAGON project (C. A. Parsons and Co., Ltd.).

LUFTFAHRT-TECHNIK GmbH and Co. KG, Dusseldorf, Berliner Allee 69, P.O. Box 5306. Tel.: 8.07.83. T.A.: Lufate Düsseldorf.
Agents of Bristol Siddeley Engines, Ltd., Nuclear Division, and Bendix International.
Precision mechanisms, instrumentation.

LURGI GmbH, Frankfurt (Main), Gervinusstr. 17/19. Tel.: 55.06.51.
Engineering and service.
Planning, design and construction of plant for treatment of U and Th ores, for removing radioactive waste; decontamination of exhaust air, gases, liquids and effluents; de-activation of reactor circuits and reprocessing irradiated atomic fuel. Engineering work in the erection of atomic reactors for research purposes, power production and chemical processes; construction and equipment of hot laboratories and institutes for atomic research in conjunction with Leybold HVA, Köln, and F. Uhde GmbH.

LUWA GmbH, Frankfurt/Main, Hanauer Landstr. 200/202. Tel.: 4.85.41. T.A.: Luwa Frankfurtmain.
Associate Companies: Luwa Werke in Paris, Barcelona, Sao Paulo, Charlotte (U.S.A.).
Air conditioning, heating and ventilation equipment, filters.

MAN MASCHINENFABRIK AUGSBURG-NURNBERG AG, Nurnberg 2, Katzwangerstr. 101. Tel.: 4.80.81. T.A.: Manwerk Nürnberg.
Associate Company: G.E.C., Erith, England.
Boiler manufacture, general fabrication, precision mechanisms.
Mechanical equipment for a neutron diffraction plant (Forschungsreaktor München); heavy water heat exchanger, support and shell construction, upper and lower annular shield, top shield for Lucas Heights reactor Australia; steel construction for main workshop, heavy water heat exchangers, emergency discharge test stand, Be exchange flask, components for measurement system, upper part of the tank cover, special He vessel for control of pressure constancy, horizontal flask, closure for horizontal flask, travelling system for Be, exchange flask with accessories (hydraulic plant, cooling system, elevator, electrical equipment), travelling crane, all for Deutschen Forschungsraktor FR 2, Karlsruhe.

MANNESMANN ROHRLEITUNGSBAU GmbH, Dusseldorf, Bleichstr. 10. Tel.: 35531. T.A.: Rohrbau Nr. 08582563.
General fabrication.
Tubes and pipework (supply and erection) for 15 MW nuclear power station at Kahl through AEG, Frankfurt; for 15 MW research reactor at Karlsruhe through Kernreaktor Bau und Betriebs GmbH, Karlsruhe; 15 MW research reactor DIDO at Jülich through Nordrhein-Westfalen.

Germany (Contd.)

MOTOREN-WERKE MANNHEIM AG vorm BENZ ABT. STAT. MOTREN-BAU, Mannheim, Carl-Benz-Strasse. Tel.: 5.80.81. T.A.: Alterbenz Mannheim.
"No break" power supply sets for Karlsruhe and Merlin reactors. Emergency stand-by sets for Karlsruhe, Kahl and Merlin.

MEDIZINISCHE TECHNIK. ING. AUGUST HOFMANN, Bamberg, Stuffenbergstr. 140. Tel.: 44.25. T.A.: Hofmann, Bamberg.
Agent for RCL nuclear instruments in the Federal Republic of Germany.

E. MERCK AG, Darmstadt. Tel.: 80.21. T.A.: Emerk Darmstadt.
Nuclear grade metals and U compounds in research quantities.

ASBEST-UND GUMMIWERKE MARTIN MERKEL KG, Sanitasstr., Hamburg-Wilhelmsburg 1. Tel.: 751586. T.A.: Merkelwerke Hamburg.
Packings, seals, lip-cups and v-rings for hydraulics.

METTLER-WAAGEN SPOERHASE AG, Giessen/Hessen, Schottstrasse 2-4, Postfach 2346. Tel.: 48.41. T.A.: Spoerhase Giessen.
Instrumentation.
Analytical, multi-purpose and precision balances of various types to GFKF-Gesellschaft zur Forderung der kernphysikalischen Forschung e.V, Aachen, Bensberg, Jülich; RWE Atom-Versuchskraftwerk Kahl/Main Kernreaktor Bau-und Betriebsgesellschaft, Karlsruhe; Kernreaktor Garching b. Munchen; Kernreaktor Gesthacht/Elbe; and various isotope laboratories.

MUNK AND SCHMITZ VERTRIEBSGESELLSCHAFT mbH, Koln-Poll, Poller Kirchweg 92-104. Tel.: 83001. T.A.: Munkwerke Köln.
Vacu-Blast dust-free sand blasting plants, e.g., for interior sand blasting of high pressure tubes and heat exchangers (instead of pickling); treating with non-metallic blasting materials of fuel elements, return tubes, fuel cans, covers with inserted tubing, wire matting of Va plated skips for fuel elements, cleaning of welds before ultrasonic or X-ray testing.

NUKEM, NUKLEAR-CHEMIE UND METALLURGIE GmbH, Wolfgang bei Hanau/Main. Tel.: Hanau 6911. T.A.: Nukem Wolfgang.
Associate Companies: Rio Tinto Management Services (U.K.), Ltd., London, E.C.2; Mallinckrodt Nuclear Corporation, St. Louis; Degussa, Deutsche Gold-und Silber-Scheideanstalt vorm. Roessler, Frankfurt (Main).
General fabrication, specialist materials.
Equipment for uranium refining to the following: CNEA, Argentine; JEN, Spain; CNRN, Italy; AEE, India; fuel element fabrication for a Japanese firm. Fuel elements for Karlsruhe research reactor FR 2, also Siemens SAR-reactor, Garching; AEG research reactor, Kahl; and thorium rods for Karlsruhe research reactor FR 2.

DR. C. OTTO AND COMP. GmbH, Bochum, Christstr. 9. Tel.: 3.73.1. T.A.: Ottokoks Bochum.
Specialist materials.

PHOENIX-RHEINROHR AG, VEREINIGTE HUTTEN-UND ROHREN-WERKE, Dusseldorf, August-Thyssenstr. 1. Tel.: 8241. T.A.: Phoenix-rheinrohr.
Associate Company: Vereinigter Rohrleitungsbau GmbH, Düsseldorf.
Boiler manufacture, specialist materials.
Decontamination vessel, core shell—upper part, for Reaktor Kahl; tubes for heat exchanger, metal sheets for housing for high temperature power reactor, Jülich; non-destructive material testing for the shielding of DIDO reactor, Jülich.

PHYSIKALISCH-TECHNISCHE WERKSTATTEN DR. PYCHLAU KG, Freiburg im. Breisgau, Lorracherstr. 7. Tel.: 3.17.10. T.A.: Petewe Freiburgbreisgau.
Instrumentation, detection and monitoring of gamma-rays.
Condiognom (pen-dosemeter with double-chambers) to Kernreaktor Bau-und Betriebsgesellschaft, Karlsruhe, Weberstr. 5; monitor (integrating dosemeter for personal protection with acoustic signal) to Kernreaktor Bau-und Betriebsgesellschaft, Karlsruhe, Weberstr. 5; monitor (integrating dosemeter for personal protection with acoustic signal) to Reaktorstation Garching, Garching b. München.

POETSCHKE AND CO. oHG, Frankfurt/Main 1, P.O. Box 2766. Tel.: 0611/551688. T.A.: Nuclear Frankfurtmain.
Instrumentation.
Radiation protection instruments, health service, personnel protection to Versuchsatomkraftwerk Kahl am Main (AVR), AEG-RWE; Kernreaktor der Universitat Frankfurt/Main FRF to AEG, Frankfurt am Main, AEG-Hochhaus and Johann-Wolfgang-Goethe-Universität, Frankfurt/Main, also water monitoring, air monitoring, protective clothing.

PRAZISIONSMESSGERATE RSV DR. H. RITZL AND DR. R. SEITNER oHG, Hechendorf/Pilsensee, Inningerstr. 17.
Light electrical and instrumentation.

RADIUM-CHEMIE DR. V. GORUP KG, Frankfurt/Main, Untermainkai 34. Tel.: 336210. T.A.: Badchemie.
Associate Company: Buchler and Co., Braunschweig, Frankfurterstr. 294.
General fabrication, precision mechanisms, instrumentation, specialist materials.

ROCHLING'SCHE EISEN-u STAHLWERKE GmbH, Volklingen/Saar. Tel.: Voelklingen 3511. T.A.: Röchling Volklingen.
Specialist materials.

GEBR. ROHR. Krefeld-Uerdingen. Tel.: 402.42. T.A.: Bleiroehr Krefelduerdingen.
Lead shield parts, blocks, isotope containers, linings for reactor tanks, reactor tube casings, linings of fuel element exchange flasks, etc.

SAMESREUTHER AND CO. GmbH, Butzbach/Hessen, Kaiserstr. 13-15. Tel.: 40.11. T.A.: SACO.
Boiler manufacture.
Thin film evaporator to Kernreaktor, Karlsruhe; thin film evaporator to Ing. Anderson for Royal Danish Reactor Centre.

BENNO SCHILDE MASCHINENBAU AG, Bad Hersfeld. Tel.: 1701. T.A.: Trockenschilde Badhersfeld.
Manufacture of air conditioning plants, industrial dryers and furnaces, surface treating plants.

AUG. SCHNAKENBERG AND CO., Wuppertal-Barmen, Beyenburgerstr. 146/168. Tel.: 41055. T.A.: Ascoblei Wuppertal.
Specialist materials.
Homogeneous leading of the thermal shield for a material test reactor; homogeneous leading of a gamma shield; complete manufacture (steel and lead) of storing tubes for fuel elements; leading of a lead-boral slide valve for thermal column; leading of a fuel element exchange flask.

SIEMENS AND HALSKE AG WERNERWERK FUR MESSTECHNIK, Karlsruhe-West, Rheinbruckenstr. 50. Tel.: 89.51. T.A.: Wernerwerkmess Karlsruhe.
Light electrical, precision mechanisms, instrumentation.
Measuring transformers, controllers, adjusting devices, impulse channels, linear and logarithmic channels, complete control systems, nuclear engineering and conventional equipment, measurement evaluating equipment, for Kernreaktor Bau- und Betriebs-GmbH, Karlsruhe (FR 2 reactor, Karlsruhe and Siemens-Argonaut reactor, Karlsruhe); also for Siemens-Schuckertwerke AG, Munich (Siemens-Argonaut reactor and Siemens-Untersuchungs-reaktor SUR 100).

SIEMENS-PLANIA CHEMISCHE FABRIK GRIESCHEIM, Meitingen, near Augsburg. Tel.: Meitingen 321. T.A.: Siemensco Meitingen.
Associate Companies: Siemens-Planiawerke Aktiengesellschaft fur Kohlefabrikate Meitingen uber Augsburg; Farbwerke Hoechst AG vorm Meister Lucius and Bruning, Werk Griescheim; Frankfurt (M) Griesheim.
Graphite exponential pile and graphite balls for Arbeitsgemeinschaft BBC/Krupp; graphite for ARGONAUT for Siemens-Schuckertwerke, Institute of Technology, Barcelona, AEG, Frankfurt/M.; graphite for thermal column for Kernreaktor Bau- und Betriebsgesellschaft, Karlsruhe; graphite for the reflector and the thermal column to German DIDO-Jülich.

SIEMENS-SCHUCKERTWERKE AG, Werner-von-Siemensstr. 50, Erlangen. Tel.: 811. T.A.: Siemenschuckert Erlangen.
Associate Companies: Siemens and Halske Aktiengesellschaft, München; Siemens-Reiniger-Werke AG, Erlangen; Siemens-Planiawerke AG, Meitingen über Augsburg.
Heavy and light electrical, general fabrication, precision mechanisms, instrumentation, planning of complete nuclear power stations.
24 coarse, 2 fine control rods for heavy water reactor FR 2, Kernreaktor Bau- u. Betriebs GmbH, Karlsruhe; Siemens Argonaut reactor for SAR Station, Garching/Bavaria to Siemens-Schukertwerke AG; Siemens Argonaut reactor for radiochemical institute to Kernreaktor Bau- u. Betriebs GmbH, Karlsruhe.

DIPL. ING. GEORG SPINNER, Munich 2, Erzgiessereistr. 33. Tel. 55.46.72. T.A.: Spinnerstecker.
Instrumentation.
Wave guide components such as bends, twists, variable shorts, terminations, etc., clotted lines to Kernreaktor, Karlsruhe; Kernforschungszentrum, Karlsruhe; Institut für Kernfusion, Aachen; Deutsches Elektronen Synchrotron, Hamburg.

OPTISCHE WERKE C. A. STEINHEIL SOHNE GmbH, Munchen 8, Germersheimerstr. 10. Tel.: 44.45.23. T.A.: Optikmunchen.
Instrumentation.
Universal spectrograph GH to Anorgan Chem. Institut der Universität, München; spectrum projector comparators to CEA, Paris, and Euratom, Ghent.

L. AND C. STEINMULLER GmbH, Gummerscach/Rhld. Tel.: Gummersbach 2851. T.A.: Steinmüller Gummersbach.
Boiler manufacture.
Decontamination plant to Reaktorbau-und Betriebsgesellschaft, Karlsruhe; under cooler for D_2O 80 t/h to Reactor Halden, Norway.

SUDDEUTSCHE KABELWERKE ZWEIGNIEDERLASSUNG DER VEREINIGTE DEUTSCHE METALLWERKE AG, Mannheim, Waldhofstr. 244. Tel.: 54.0.51. T.A.: Sudkabel.
Light electrical.

SUNVIC REGLER GmbH, Abt. Nukleonik, Solingen-Ohligs, Hackhauserstr. 66a. Tel.: 1.42.25. T.A.: Sunvicregler Solingen.
Associate Company: A.E.I.
Instrumentation, specialist materials.
Almost all German scientific institutes supplied; hot water disposal systems for University reactor, Vienna (under construction); industrial use of isotopes for large German chemical companies.

FRIEDRICH UHDE GmbH, Dortmund, Degginstr. 10-12. Tel.: 20.71. T.A.: Uhdeingeineur Dortmund.

VEREINIGTE BLEIWERKE GmbH AND CO., Stolberg Rhl., Binsfeldhammer 40. Tel.: 3031. T.A.: Bleiwerke Stolberg.
Associate Companies: Zwigwerk Mannheim der V.B.Z. Mannheim-Industriehafen; Bleitechnik Donnersberg, Ohlerer and Co., Mannheim-Käfertal.
Specialist lead materials.
Lead for X-ray protection in bricks, plates, tubes and castings to German reactor stations, institutes, laboratories of universities.

VEREINIGTE DEUTSCHE METALLWERKE AG, Hauptniederlassung, Heddernheimer Kupferwerk, Frankfurt (Main). Tel.: 52.00.21. T.A.: Verdemet Frankfurtmain.
Specialist materials to Kernreaktor Bau- und Betriebs GmbH, Karlsruhe.

VEREINIGTE ECONOMISER-WERKE GmbH, Hilden, Eichenstr. 2. Tel.: 27.21.27. T.A.: Ecowerke Hilden.

VEREINIGTE KESSELWERKE AG, Dusseldorf, Werdnerstr. 3. Tel.: 7.42.61. T.A.: Kesselwerke Düsseldorf.
Boiler manufacture.
Heat exchanger for 15 MW subcooler, erection research reactor, steam generator for 15 MW HT reactor, tank equipment for reactors in Western Germany.

VEREINIGTE LEICHTMETALL-WERKE GmbH, Bonn Am Nordbanhof. Tel.: 3.19.11. T.A.: Leichtmetall Bonn.
Light metals fabrication.

DR. VIRUS KG, Bonn, Rosenburgweg 24. Tel.: Bonn 24924. T.A.: Dr. Virus Bonn.
Nuclear instrumentation supplied to universities, research institutes, industry and private laboratories.

WALBERSDORF SONDERMASCHINENBAU, Siegen/Westf. Bahnhof Eintracht 1. Tel.: 22.306. T.A.: Walbersdorf Sondermaschinenbau Siegen I.W.
Pumps.

HANS WALISCHMILLER, Meersburg Bodensee. Tel.: Meersburg 223. T.A.: Meersburg.
General fabrication, precision mechanisms, specialist materials.
Remote control equipment to Radiochemistry lab. Farbwerke Hoechst Institut fur Radiochemie, TH München Hahn-Meitner-Institut, Freie Universität, Berlin, Institut für Radiochemie der Kernreaktor Bau- und Betriebsgesellschaft, Karlsruhe; hot cell equipment to Schiffsreaktor GmbH Geesthacht Institut für Radiochemie, TH München Hahn-Meitner Institut, Freie Universität, Berlin; glove box system for work with high levels of alpha activity to Laboratory for Lanthanide and Actinide Chemistry, Institut für Anorganische Chemie der Universität, München. Storage cells for radioactive materials and fume hoods for radioactive materials to various laboratories.

Germany *(Contd.)*

HERMANN WALDNER KG, Wangen im Allgau, Im weissen Bild 26. Tel.: 8383. T.A.: Waldnerwangenallgäu.
Laboratory furniture installation for CEN, Mol, Belgium; Headquarters of International Atomic Energy Agency, Vienna, Austria.

WILKE-SAUREBAU, Bonn (Rhein) Dransdorfer Weg 25, P.O. Box 622. Tel.: 3.73.47. T.A.: Kerambau Bonn.
Linings for tanks, channels and floors to CEN, Mol; SORIN, Milano; and Interatom, Bensberg.

DEUTSCHE WORTHINGTON GmbH, Hamburg 1.
Parent Company: Worthington Corp., Harrison, N.J., U.S.A.
Associate Companies: Worthington-Simpson, Ltd., U.K.; Sté. Worthington, Paris; Worthington-Sipec, Milan; Worthington S.A., Madrid; Worthington, Vienna.
Condenser manufacture; general fabrication, instrumentation.
Reactor feed pumps, 8 WC–137; condensate circ. pumps, Hiflo 60 in.; vertical condensates, QEBC–4; "HB" compressor, "HBB" compressor; ejectors; main condenser (built under Worthington licence by Ansaldo S.A., Italy); all for SENN at Punta Fiume, Southern Italy (IGEO, Rome).

Liechtenstein

BALZERS AG, Balzers, Principality of Liechtenstein. Tel.: 4.11.22. T.A.: Interferencia Balzers.
Associated Companies: Balzers Vakuum Gm.b.H., Frankfurt; Balzers High Vacuum, Ltd., 1 Mornington Terrace, Regents Park, London, N.W.1.
High vacuum pumps, ultra-high vacuum pumps, measuring equipment, valves, control equipment vacuum relay, oil and mercury diffusion pumps, etc. Complete vacuum equipment for proton synchrotron for CERN, Geneva; Furnaces, pumps, measuring equipment, ultra-high vacuum equipment for CEA, CEN, Saclay; furnaces, vacuum equipment for Reaktor AG Würenlingen, Switzerland; furnaces, measuring equipment, pumps, etc., for U.K. AEA; 7 furnaces for preparation of graphite, uranium, to SICN, Annecy, ICI, Birmingham.

Italy

AGIP NUCLEARE S.p.A., Casella Postale 4179, San Donato Milanese (Milan). Tel.: 53.53. T.A.: Agip Nucleare Milan.
Associate Companies: Nuovo Pignone, Florence; Saipem, Milan; members of the ENI group.
Boiler manufacture, general fabrication.
Supply of six heat exchangers for Latina power station (Nuovo Pignone); erection of pressure vessel and CO_2 ducts for Latina (Saipem), in both cases supplied to SIMEA, which is controlled by Agip Nucleare.

SOCIETA DELL'ALLUMINIO ITALIANO, Borgofranco d'Ivrea, Turin. Tel.: 44.88. T.A.: Alluminio Borgofranco.
Associate Company: Aluminium, Ltd. (Canada).
General fabrication.

ANGST AND PFISTER S.p.A., Via Ferrante Aporti, 14, Milan. Tel.: 21.21.42. T.A.: Packing.
General fabrication.

ANSALDO S.A., Piazza Carignano 2, Genoa. Tel.: 587351. T.A.: Ansaldosa Genoa.
Boiler and turbine manufacture, general fabrication.
Turbine and condenser for nuclear power plant at Garigliano (SENN) and nuclear research facility (Euratom).

STABILIMENTI ELECTROMECCANIC RIUNITI ANSALDO-SAN GIORGIO, Via Corsica 21, Genoa. Tel.: 586.741. T.A.: Seras Genoa.
Heavy electrical.
Variable frequency alternators to control CO_2 blowers for Latina (Agip Nucleare); main generator and ancillary equipment, various motors for water circuit pumps, condensate extraction, etc., for Garigliano (SENN).

SANTINO E MARIO BERAUD, Soc. in Nome Collettivo, Via M. Agrate, 33, Milano. Tel.: 530.320.
Painting and associated services and equipment for power stations, etc.—in particular the nuclear power plant of Sorin di Saluggia (Vercelli).

BREDA TERMOMECCANICA E LOCOMOTIVE S.p.A., Casella Postale 3778, Milan. Tel.: 69.97. T.A.: Breda Termolocomotive Milan.
Associate Companies: Member of Finanziaria Ernesto Breda group.
Boiler manufacture, general fabrication.
Steam generators under licence from Babcock and Wilcox.

ACCAIERIA AND TUBIFICIO DI BRESCIA, Via Zara 12, Brescia. Tel.: 53361. T.A.: Atub Brescia.
Boiler manufacture and general fabrication.
Primary steam drum for SENN thermonuclear power station, Garigliano (International General Electric Operations S.A.).

CANTIERI RIUNITI DELL'ADRIATICO, S.p.A., Corso Cavour 1, Trieste. Tel.: 36.641. T.A.: Cantnavale Trieste.
Licencees of Babock and Wilcox Co., New York.
Nuclear plants for ships.

CAREM, Ripa Ticinese n. 115, Milan. Tel.: 857769.
Laboratory furniture.

F. CASINGHINI ECONOMIZZATORI GREEN, Via Larga, 9, Milan. Tel.: 877152. T.A.: Economiser Milan.
Heat exchangers.

CERETTI AND TANFANI S.p.A., Via G. Durando, n. 18, Milan. Tel.: 373.277. T.A.: Cerettanfa Milan.
General fabrication.
Overhead travelling cranes with circular runways for Saclay (CEA) and for Ispra (CNRN); overhead travelling cranes for Marcoule (CEA) and Latina and Geneva (SIMEA and CERN); gantry cranes for Latina and Dungeness (SIMEA and NPPC).

CGE, Via Bergognone 34, Milan. Tel.: 47.01.61. T.A.: Cogenel Milan.
Associate Companies: FIAR, Milan; Scotti Brioschi and Co., Novara.
Heavy and light electrical.
Electrical equipment to feed the power windings of the electro-synchrotron, Frascati (CNRN).

SOCIETA CISE, Via Redecesio 12, Segrate (Milan), Casella Postale 3986. Tel.: 23.00.18.
Nuclear Research Institute financed by private and public groups.

CNEN, Via Belisario 15, Rome. Tel.: 478551. T.A.: Nucleare Rome.
Fundamental and applied research.

DALMINE S.p.A., Via Brera 19, Milan. Tel.: 88.58. T.A.: Tubidalmine Milan.
Associate Companies: Ponteggi Tubolari Dalmine Innocenti S.p.A., Milan; Montubi S.p.A., Milan.

SOCIETA EDISON, Via Foro Buonaparte 31, Milan. Tel.: 88.35. T.A.: Edison Milan.
Associate Company: SELNI, Societa Elettronucleare Italiana, who are building a nuclear station of 165 MW equipped with a PWR reactor.

EIGENMANN AND VERONELLI S.p.A., Piazza S. Maria Beltrade 8, Milan. Tel.: 88.56. T.A.: Eigenmann Milan.

FIAT S.p.A., Sezione Energia Nucleare, Via Settembrini 235, Turin. Tel.: 396953. T.A.: Nuclearfiat Turin.
Associate Companies: SORIN, and ITALATOM, Milan.
General fabrication, precision mechanisms, instrumentation, specialist materials.
Large irradiation window, electronic equipment, general purpose radiation for swimming pool research reactor, Saluggia (Vercelli), (SORIN); detection chains for LRCAA, Turin.

GILARDONI S.p.A., Mandello Lario, Como. Tel.: 71.221. T.A.: Gilraggi Mandello Lario.
Associate Company: Apel, Mandello Lario.
Light electrical, specialist materials.
X-ray generator for Enrico Fermi (Politecnico Milan); X-ray generator with beryllium window and Gilardoni dosimeter (Centro Applicazioni Militari Energia Nucleare Livorno).

A. GUFFANTI AND CO., Via Goldoni 19, Milan. Tel.: 716.651.
Associate Companies: SALF, SALL, Como; Guffanti, Boniger, Ibadan (Nigeria).
General fabrication.
Construction of the Ispra (Varese) nuclear station plants: reactor building, laboratory buildings, stores, offices, road, etc.; construction of the Frascati "Sincrotone" (Rome); for CNRN; earthworks, masonry and reinforced concrete for the proton synchrotron (CERN, Geneva).

ISTITUTO DI RICERCHE BREDA, 336 Viale Sarca, Milan. Tel.: 69.97. T.A.: Breda Istituto Milan.
Non-destructive testing; industrial applications of radioisotopes.

ITALETTRONICA S.p.A., Via Ignazio Pettinengo 72, Rome. Tel.: 496628.
Heavy electrical, precision mechanisms, instrumentation.
Sealers, autoscalers, stabilized power supplies, linear amplifiers, fast pulse amplifiers, photomultipliers, metal-wall G.M. tubes, discriminators, portable survey meters, ionization chambers, ratemeters, mass spectrometers (CNRN, Rome; SORIN, Saluggia; Montecatini, Milan; Somiren, Milan; Istituto Superiore di Sanita, Rome; and various Italian universities).

FRATELLI KORISTKA S.p.A., Via Ampere 43/45, Milan. Tel.: Milan 292445 T.A.: Koristka Milan.
Precision mechanisms.
Nuclear track scattering microscopes.

LABEN—S.R.L. LABORATORI ELECTTRONICI E NUCLEARI, Via Amadeo 41, Milan. Tel.: 712.494. T.A.: Laben Milan.
Instrumentation.
200 channel pulse height analysers for the swimming pool reactor, Saluggia (SORIN), the proton synchrotron, Geneva (CERN), the electro-synchrotron, Frascati, Trign and CP 5 reactors Casaccia and Ispra (CNRN), and milli-microsecond time analyser for CP 5 reactor, Ispra.

SOCIETA' ELETTRONICA LOMBARDA, Via Monfalcone 12, Milan. Tel.: 25.2030.
Instrumentation.
Alpha and gamma spectrometry equipment, including 100 channel analyser, for CISE, Milan, also for universities of Milan, Turin, Florence; neutron generator, Naples University; air radio-activity control and low activity measurements (anti-coincidence system), Casaccia, Rome; Lab. di Igiene e Profilassi, Milan; Padova University; Parma University; radioisotopic laboratory equipment, LV and HV stabilized power supplies for university and industrial laboratories.

FABBRICA ITALIANA MAGNETI MARELLI S.p.A., Casella Postale 66, Sesto S. Giovanni (Milan). Tel.: 2470091. T.A.: Magmarelli Sesto S. Giovanni.
Associate Company: FIVRE, Milan.
Instrumentation.
Radio frequency accelerating units for proton synchrotron, Geneva (CERN); closed circuit television controls for experimental reactor, Ispra (CNRN).

MAGRINI S.p.A., Via L. Magrini 7, Bergamo. Tel.: 35.444. T.A.: Electtromagrini.
Heavy and light electrical.
Switchboards for low and medium voltages for Frascati (Istituto Nazionale di Fisica Nucleare), BR 3, Mol (CEN), Ispra (CNRN), and Latina (Agip Nucleare).

MONTECATINI, Largo Donegani 1-2, Milan. Tel.: 6333. T.A.: Gabbro.
Operation of chemical plant, consultant engineers.
Co-operation in the design of a nuclear organic reactor plant (Comitato Nazionale Energia Nucleare, CNEN).

OFFICINE BOSSI S.p.A., Via Revere, 14, Milan. Tel.: 439.251. T.A.: Ferbossi Milan.
Associate Company: Edison Co. Group, Milan.

OFFICINE GALILEO S.p.A., Via Carlo Bini 44, Florence. Tel.: 413645. T.A.: Galileo Florence.
Associate Companies: OTE, Florence; Officine Galileo di Milan; Officine Elettromeccaniche Galileo di Battaglia Terme.
Light electrical, general fabrication, precision mechanisms, instrumentation.
High-vacuum equipment (pumps, accessories, remote-control stations) for research plants Saclay (CEA), Geneva (CERN), Frascati (INFN), Ispra (CNRN), and Boris Kidric Institute, Beograd.

OLMI S.p.A., Officina Lavorazione Metalli Inossidabili, Via Sannio 6, Milan. Tel.: 554.392. T.A.: Olminox Milan.
Spectrometric mass tubes of copper, inconel and stainless steel for Physical Institute, University of Genoa; autoclaves and stainless steel apparatus for U extraction for Institute of General Chemistry, University of Padua; pilot U extraction plant for SOMIREN, S. Donato Milanese (Milan); hot cells: groups of apparatus for active and inert liquids for CISE, Milan; automatic components for nuclear reactor hall and dampers for air circuit for Inst. of Physics Enrico Fermi, Polytechnical of Milan; various constructions and special pipelines and various devices pertaining to the equipment installed for NUCLIT (Ispra centre).

PASSONI AND VILLA S.p.A., Viale Suzzani 229, Milan. Tel.: 64.21.451. T.A.: Pasvilla.
Heavy electrical.
D.C. generator for injector of synchrotron (CNRN, Frascati, Rome); D.C. generators for ion accelerators (Istituto di Fisica, Trieste, and Bologna, and CISE, Milan); special bank of capacitors for high intensity current (Istituto di Fisica, Padova and CERN, Geneva).

LABORATORI ING. C. PAVONE S.p.A., Via Natale Battaglia 12, Milan. Tel.: 2898.141. T.A.: Ingepavo Milan.

Italy (Contd.)

SOC. ELETTROTECNICA ING. F. E G. PISTORELLI AND CO., Via S. Giovannida Verdara, 46, Padova. Tel. 20770. T.A.: Elettrotecnica Pistorelli.
Heavy electrical.
Transforming station and 2 metal-clad transforming stations, 2 distribution switchboards for Saluggia (SORIN).

SACE S.p.A., COSTRUZIONI ELETTROMECCANICHE, Via Baioni 35, Bergamo. Tel.: 38.444. T.A.: Sace Bergamo.
Light electrical.
Protected L.V. and H.V. sub-station for Geneva, CERN (Ansaldo S. Giorgio S.p.A., Genoa); L.V. L. metal clad switchboard, 3 sub-stations, M.V. 20 unit metal clad switchboard for Ispra (CNRN); 3 L.V. metal clad switchboards (36 units), and 7 L.V. metal clad switchboards for Latina (Agip Nucleare).

SELNI, SOCIETA ELETTRONUCLEARE ITALIANA, Via Foro Buonaparte 31, Milan.
Associate Company: Societa Edison, Milan.
Construction of a nuclear station of 165 MW equipped with a PWR reactor.

SOCIETA ELETTRONUCLEARE NAZIONALE (SENN), Via Torino 6, Rome. Tel.: 486441. T.A:: Elettronucleare Rome.
SENN is an electric utility company formed with the express intention of erecting and operating a nuclear power station in Italy. A 150 MW BWR supplied by G.E. of U.S.A. is in course of construction at Garigliano.

SORIN, SOCIETA RICHERCHE IMPIANTI NUCLEARI, Via Montebello 39, Milan. Tel.: 667.587. T.A.: Sorin Milan.
Heavy and light electrical, general fabrication, instrumentation.
Conception, design and management of nuclear research and trial nuclear plants for power production.

STUDIO PROGETTI IMPIANTI NUCLEARI, Via Pisani 12, Milan. Tel.: 652.414. T.A.: Studio Progetti Impianti Nucleari.
Associated with: Babcock and Wilcox, Ltd., English Electric Co., Ltd., Societa Ansaldo S.p.A., Breda Termomeccanica and Locomotive S.p.A.
Consultant engineers; boiler manufacture, specialist materials.

TERMOMECCANICA ITALIANA S.p.A., La Spezia. Tel.: 23251. T.A.: Termomeccanica La Spezia.
Member of the Finmeccanica Group of the IRI concern.
Water demineralizers for SENN (Intern. Gen. Electric Rome); make-up water demineralizer, water softening plant, waste disposal plant, for CAMEN swimming pool reactor (Vitro Italiana).

TERNI, SOCIETA PER L'INDUSTRIA E L'ELETTRICITA, Via due Macelli 66, Rome. Tel.: 689.351 Rome. T.A.: Elettroterni Rome.
Heavy electrical, boiler manufacture, general fabrication, specialist materials.
Reactor pressure vessel, heat exchangers, emergency condenser for Garigliano, SENN (IGEO—Italian division of U.S.A. General Electric Co.); spherical container, generator shaft for Garigliano (IGEO and Ansaldo-San Giorgio); heat exchanger flanges for Latina, SIMEA (Agip Nucleare).

DOTT. ING. G. TORNO AND C. S.p.A., Via Albricci 7, Milan. Tel.: 802.741. T.A.: Idrotorno.
Associate Companies: Consonda S.p.A.; Ediltorno S.p.A.
Civil engineering contractors.
Work for Latina power station and also Enrico Fermi.

FRANCO TOSI S.p.A., Corso Italia 27, Legnano. Tel.: 47690. T.A.: Tosi Legnano.
Steam turbine and boiler manufacture, general fabrication.
Steam turbine for SELNI; steam condensers, heat exchangers, piping, etc., for Latina (Agip Nucleare); primary steam drum for steam generating system and heat exchangers for Garigliano, SENN (IGEO).

VITRO ITALIANA S.p.A., Piaza Repubblica 12, Milan. Tel.: 63.71.57. T.A.: Vitroworld Milan.
Associate Company: Vitro Corporation, New York.
Heating, ventilation, air conditioning, water facility constructions and reactor assembly treatment, waste disposal, electrical instrumentation, sanitary services for Ministero Marino CAMEN, Accademia Navale, Livorno; similar equipment, designing and construction for high level radio-metallurgical labs. facility (CNRN, Rome).

Netherlands

N.V. MACHINEFABRIEK BREDA VOORHEEN BACKER EN RUEB, Speelhuislaan 173, Breda. Tel.: 01600/24281. T.A.: Machinefabriek.
Light electrical, boiler manufacture, general fabrication, instrumentation.

G. DIKKERS AND CO. N.V., Industriestraat, Hengelo (O). Tel.: 05400/3344-7961. T.A.: Dikkers Hengelo.
Valve manufacture.
Stainless steel and steel valves for OEEC Halden reactor (Institute for Atomic Energy, Norway); stainless steel valves for UO_2 suspension reactor (N.V. tot Keuring van Electrotechnische Materialen—KEMA); stainless steel, aluminium and steel valves for MTR Petten, Holland (A.C.F./Tebodin); stainless steel valves for experimental work, Sweden (A.B. Atomenergi, Stockholm).

DUPER WATERREINIGING N.V., Nieuwendammerkade 1-3, P.O. Box 196, Amsterdam. Tel.: 020/60821. T.A.: Waterduper.
Associate Companies: Koninklijke Zwavelzuurfabrieken voorheen Ketjen N.V. (Royal Sulphuric Acid Co., late Ketjen, Ltd.); Industrieele Maatschappij Activit N.V., Amsterdam.
All kinds of water conditioning apparatus for cooling systems (primary loop and pool systems) and treatment of radioactive waste water. Demineralizing installations for the primary loop system and the pool system for RCN, Petten; treatment of laboratory waste water by means of precipitation and ion exchange and treatment of laboratory waste by precipitation for RCN.

L'ELECTRO-NAVALE AND INDUSTRIELLE S.A., Kontichsesteenweg, Aartselaar (lez Anvers). Tel.: 77.40.81. T.A.: Electroni Anvers.
Associate Companies: M.M.E.W. and Physique Industrielle, Anvers.
Heavy and light electrical, general fabrication, instrumentation.
Pneumatic dispatch system for irradiation of samples and electrical installation for University of Ghent experimental reactor (Belgonucleaire).

INTERLAS N.V., Amersfoortsestr. 15, Soesterberg. Tel.: 0.3463-644.
Associate Company: Interlas, Ltd., Ampthill, Bedford.
Welding plant and accessories, lifting gear.

FIRMA KOCKEN (LOOINDUSTRIE), Vleutensevaart 12, Utrecht. Tel.: 030/30118.
Lead, instrumentation.

N.V. KONINKIJKE NEDERLANDSCHE MACHINEFABRIEK v.h. E. H. BEGEMANN, Kanaaldijk 31, Helmond. Tel.: 2841. T.A.: Begemann Helmond.
Boiler manufacture, general fabrication, specialist materials.
Pumps for KEMA, Arnhem.

KOOPMAN AND CO. TECHNISCHE HANDEL MIJ., N.V., Gebouw "Atlanta", Stakhouderskade 6, P.O. Box 6049. Tel.: Amsterdam 82821. T.A.: Kjoebmand Amsterdam.
Associate Company: Koopman A and Co. S.A., Brussels.
Agents for: Test Equipment, Ltd., England; Panatron, Ltd., England; Industrial Nucleonics Corp., U.S.A.; Kaman Nuclear Division, U.S.A.; Westinghouse Atomic Power Corp., U.S.A.
Heavy and light electrical, precision mechanisms, instrumentation, specialist materials.
Research irradiation unit and isotope source for Leiden University (Panatron, Ltd., London); large irradiation unit and source for research for T.N.O.-R.V.O. research institute, Rijswijk, Holland (Panatron, Ltd., London); radiographic isotope container for R.T.D., Schiedam, Holland (Nuclear Engineering, Ltd., London).

N.V. LEIDSCHE APPARATENFABRIEK, Os en Paardenlaan 41-43, Leiden. Tel.: 1710/3.07.45. T.A.: Ellaef Leiden.
General fabrication.
Mild steel, stainless steel and aluminium tanks, vessels, filters, tubes, piping for reactor at Petten, Holland (ACF—Allis Chalmers); aluminium tanks for Swedish reactor (ACF—Allis Chalmers).

N.V. NEDERLANDSCHE ELECTROLASCH MIJ., Zoeterwoudseweg 1, Leiden. Tel.: 22941. T.A.: Nem Leiden.
Associate Companies: N.V. Hollandsche Constructiewerkplaatsen, Leiden; N.V. Rijnlandsche Metaalbescherming Mij. Leiden; N.V. Tebodin, The Hague.
Boiler manufacture, general fabrication.
Most of the major components for swimming pool reactor, beams, tubes, and shutter mechanisms; thermal column; dry radiation chamber, aluminium doors; internal piping for Technical University, Delft.

N.V. NERATOM, Noordeinde 38, The Hague. Tel.: 070/115661.
Member Companies: Breda; Philips, Eindhoven; De Rotterdamsche Droogdok Mij. N.V.; De Schelde, Vlissingen; Gebr. Stork and Co., Hengelo; Werkspoor, Amsterdam.
Light electrical, boiler manufacture, general fabrication, instrumentation.
Primary heat exchangers for SENN power station (General Electric, Rome); circuit pumps and heat exchangers, instrumentation, core support structure for reactor at Petten (Reactor Centrum Nederland); pressurizer with instrumentation, and pressure vessel for Delft Technical University.

N.V. PHILIPS GLOEILAMPENFABRIEKEN, Eindhoven. Tel.: 04900-60000 Toestel. T.A.: Philips Eindhoven.
Associate Companies: Some 40 Philips associate companies form part of the parent company's world-wide distribution organization.
Electrical, instrumentation.
Philips manufacture a wide range of radiation measuring equipment, accelerators, D.C. generators, synchro-cyclotrons and vacuum measuring apparatus, etc.

R.T.D. (RONTGEN TECHNISCHE DIENST N.V.), Delftweg 144, Rotterdam 8. Tel.: 010/82995. T.A.: Staaltest.
Non-destructive testing services for Petten (RCN) and various nuclear installations, Dutch factories.

DE ROTTERDAMSCHE DROOGDOK MIJ. N.V. (The Rotterdam Dockyard Co.), Postbox 913, Rotterdam. Tel.: 010/176920. T.A.: Dockyard.
Associate Companies: Members of the Neratoom group.
Boiler manufacture, general fabrication.
Upper grid plate assembly, thermal shield, main equipment air lock for MTR, Petten (Allis Chalmers); forged tube plates and several nozzles for steam generators for SENN BWR plant, Italy (General Electric); thermal shield for MTR (AB. Atomenergi, Sweden); test pressure vessel for Neptune project (Technical University, Delft).

THE ROYAL NETHERLANDS LEAD AND ZINC ROLLING MILLS, LATE A.D. HAMBURGER, LTD., Leidsekade 30, P.O. Box 2070, Utrecht. Tel.: 030/30946. T.A.: Royalpletterij.
Lead and zinc manufacture.
Leadscreens, lead bricks, flat and profiled; containers for isotopes, lead castles, and containers for RCN, Petten, and Rontgen Technische Dienst, Leiden.

VAN HATTUM EN BLANKEVOORT N.V., Velserweg 10, Beverwijk, P.O. Box 3. Tel.: 3341. T.A.: Vehabe Beverwijk.
Dredging, civil engineering contracts.
Cooling water pipes and outlet to the sea at Petten.

WERKSPOOR N.V., Ostenburgermiddenstraat 62, Amsterdam. Tel.: Amsterdam 744111. T.A.: Werkspoor.
Associate Companies: Member of Neratoom.
Heavy and light electrical, precision mechanisms, instrumentation.
Pool liner, large facility plug liner, bottom plug liner, aluminium piping, beam hole plugs for experimental high flux reactor, Petten (ACF—Allis Chalmers); complete erection of reactor system, personnel and equipment airlocks for Petten (RCN); pressure vessel for experimental pressurizer, Technical University, Delft (Neratoom N.V.); design aid for KEMA suspension test reactor, Arnhem (Neratoom N.V.).

Norway

EGA, ELEKTRO-GENERATOR A/S, Ovre Vollgt. 11, Oslo. Tel.: 425820. T.A.: Elektron.
Heavy electrical, boiler manufacture.
Electrical boiler for superheated water for Halden reactor (Atomic Energy Institute, Norway); electrical steam boiler with superheater (project only) for nuclear laboratory, Kjeller (Institute for Atomic Energy, Norway).

NORSK JUNGERAKKUMULATORFABRIK A/S, Hegdehaugsveien 31, Oslo. Tel.: 60.48.90. T.A.: Jungnerfabriken Oslo.
Associate Company: Svenska Ackumulator A.B. Jungner, Stockholm.
Light electrical, specialist materials.
Stationary lead battery, specially constructed steel staircase, lead covers for ion exchangers, iron gratings for Halden reactor (Institute for Atomic Energy, OEEC).

Norway *(Contd.)*

KONGSBERG VAPENFABRIK, Kongsberg. Tel.: Kongsberg 37. T.A.: Vapenfabrikken.
General fabrication, precision mechanisms.
Prototype Cadmium control station, for prototype ship reactor (Institute for Atomic Energy, Kjeller, Norway); Cadmium control station for NORA experimental reactor (Noratom A.S., Oslo).

A/S KVAERNER BRUG, Enebakkveien 65, Oslo (P.O. Box 3610). Tel.: 68.18.10. T.A.: Kvaerner Oslo.
Associate Companies: A. S. Thunes Mekaniske Vaerksted, Oslo; A. S. Myrens Verksted, Oslo.
Boiler manufacture, general fabrication.
Pressure vessel, HWBR (IFA).

CHR. MICHELSENS INSTITUTT, Dept. of Applied Physics, Nygaardsgate 114, Bergen. Tel.: 17633. T.A.: Michinst.
Precision mechanisms, instrumentation.
Reactor control and instrumentation for JEEP, Kjeller (IFA—Institute for Atomic Energy); also for BWR, Halden (Noratom A.S., Oslo).

NORATOM A/S, Holmenen 20, Vinderen, Oslo. Tel.: 60.88.80. T.A.: Noratom Oslo.
Noratom represents Norwegian industry and research establishments in the nuclear field.
Boiler manufacture, general fabrication, precision mechanisms, instrumentation.
Shielded optical inspection unit for fuel elements, fuel transfer flask, autoclaves for OEEC, Halden (Institute for Atomic Energy—IFA); bellow sealed valves, fume hoods for Halden and IFA, Kjeller; operation boxes for Alpha work, various test equipment for radiochemical laboratories for IFA, Kjeller; radioisotope production laboratory (planning and delivery of complete installation) for United Arab Republic Atomic Energy Establishment, Cairo; zero energy reactor NORA, waste treatment plant, metallurgical hot-lab. for IFA, Kjeller.

INGENIORFIRMAET THEODOR QVILLER A/S, Stenersgt. 8, Oslo. Tel.: 42.10.89. T.A.: Propeller.
General fabrication.
Ventilation plants for Halden reactor, isotope laboratory, and hot laboratory Kjeller, and air filter elements for NORA reactor, Kjeller (IFA).

A/S THUNES MEK. VAERKSTED, Drammensvn. 130, Oslo. Tel.: 55.72.90. T.A.: Thune Oslo.
Associate Companies: A. S. Kvaerner Brug, Oslo; A.S. Myrens Verksted, Oslo.
Boiler manufacture, general fabrication.
Heat exchanger for boiling D_2O reactor, Halden (Institute of Atomic Energy).

Portugal

COMPANHIA PORTUGUESA DE INDUSTRIAS NUCLEARES (CPIN), R. de S. Nicolau 26-4°, Lisbon 1. Tel.: 27155. T.A.: Reactores.
Nuclear consultants.

Sweden

ASEA GROUP (ALLMANNA SVENSKA ELEKTRISKA AB.), Vasteras. Tel.: 10.000. T.A.: Asea Västeras.
Associate Companies: Surahammars Bruks AB; AB Elektrohelios; AB Elektromekano; AB Skandinaviska Elverk; AB Liljeholmens Kabelfabrik; Voxnans Kraft AB; AB Elektrokoppar; AB Elektroskandia; AB Asea Svetsmaskiner; Graham Brothers AB; Fastighets AB Sodra Kungstornet; Luth and Rosens Elektriska AB; Cebe AB; Elektriska AB Sivers and Hager; AB Elektro-Finans; AB Harnoverken; Elektriska AB Moren; AB Dikesrenen nr 11; Västeras Bostads AB; Storviks Elektriska AB; Ludvika Bostads AB; Fastighets AB Malmaberg; AB Rodor; Forenade Elektriska AB; AB Ludvika Elektriska Byra; AB Västeras Elektriska Byra; Tullgarns Gjuteri och Mekaniska Verkstads AB; Gardsjo Industri AB; Fastighets AB Melker.
Heavy and light electrical, precision mechanisms, instrumentation.
Prime contractor for R3/Adam (Ågesta kraftvarmeverk) 65 MW(t) space heater producing also 10 MW(e) to go critical December, 1962 (Swedish State Power Board and AB Atomenergi); main design (together with NOHAB) preliminary delivery contract (together with NOHAB) erection to be decided end 1961 for R4/EVA (Marvikens kraftstation) 100 MW(e) to Swedish State Power Board; Prime contractor for R2 research reactor 100 kW, delivered June, 1960, to AB Atomenergi.

AB ATOMENERGI, Lovhomsvagen 7, Stockholm. Tel.: 19.02.60. T.A.: Aterg Stockholm.

AVESTA JERNVERKS AB, Avesta. Tel.: Avesta 505.00. T.A.: Jernverket Avesta.
Associate Companies: Rederi AB Nordstjernan, Stockholm 7; AB Karlstads Mekaniska Werkstad, Karlstad; AB Motala Verkstad, Motala.
Vacuum chamber to CSIR, Pretoria; vacuum tank and pump manifold to CERN, Geneva; dished ends and flanges to CEN, Mol; primary cooling circuit to ASEA (R3/Adam), Västeras; dished end and casing to main heat exchanger for Jönköpings Mekaniska Werkstads Jönköping; test corrosion loops to ASEA and AB Atomenergi, Stockholm.

DEGERFORS JARNVERK, DIVISION OF UDDEHOLMS AB, Degerfors. Tel.: Karlskoga 42100. T.A.: Jaernverket Degerfors.
Boiler manufacture, general fabrication, specialist materials.
Reactor pressure vessel, stainless steel thermal shields, charge tubes, etc., for R3/Adam reactor, Ågesta to AB Atomenergi; two main heat exchangers for R3/Adam to AB Rosenblads Patenter (as contractors to AB Atomenergi); pressurizing vessel for R3/Adam to ASEA (as contractors to AB Atomenergi); expansion tank for R3/Adam to ASEA (as contractors to AB Atomenergi); main heat exchanger components for Halden reactor to AB Rosenblads Patenter (as contractors); two steam accumulators of low-alloy steel for the Ranstad Uranium Works to AB Atomenergi, Ranstad.

DORCH, BACKSIN AND CO. AB, Agnesberg. Tel.: Göteborg 031.69 01 60. T.A.: Dorch Göteborg.
Specialist materials.
Paint and varnish, Dorco EPX-K, -V and G for Atomic Energy Research, Studsvik, to AB Atomenergi, Stockholm.

AB SVENSKA FLAKTFABRIKEN, P.O. Box 200 40, Stockholm 20. Tel.: Stockholm 23.83.00. T.A.: Flaktfabriken.
General fabrication.
Ventilation plants for R1, Stockholm, to AB Atomenergi; also RO Studsvik; ventilation plant including tight valves and filter casings for R2 to AB Atomenergi; and the laboratories for radioactive metallurgy, Studsvik; iodine scrubber for R2, Studsvik to AB Atomenergi; also DR 3 Risø, Denmark and BER Berlin to Hahn-Meitner-Institut für Kernforschung, Berlin.

AB GOTAVERKEN, Goteborg 8. Tel.: 23.54.80. T.A.: Götaverken.
Boiler manufacture.
Pressurizer for R3/Adam to AB Atomenergi.

AB SVENSKA JARNVAGSVERKSTADERNA, Linkoping. Tel.: Linköping 29700. T.A.: Svenska.
Boiler manufacture, general fabrication.
Regenerative heat exchangers D_2O/D_2O for operational cleaning circuits to ASEA Västeras; heat exchangers D_2O/H_2O as for above; heat exchangers for D_2O drainage water for nuclear power station and remote heating central R3/Adam.

JONKOPINGS MEKANISKA WERKSTADS AB, Jonkoping. Tel.: 19100. T.A.: Werkstaden Jönköping.
Boiler manufacture.
Two primary heat exchangers for reactor installation R3/Adam to AB Atomenergi.

DE LAVAL LJUNGSTROM TURBINE CO., Finspong Division, Finspong. Tel.: Finspong 12000. T.A.: Stalturbin-Finspong.
Associated Companies: De Laval Ljungström Pump Co., Stockholm-Nacka; De Laval Ljungström Apparat Co., Linköping.
Heavy electrical.
Steam turbine with alternator for Ågesta Atomic Power Station to City of Stockholm, Electricity Works; Reactor coolant circulating pumps for Ågesta Atomic Power Station to City of Stockholm, Electricity Works; also to Studsvik Atomic Energy Research Station to AB Atomenergi.

SVENSKA MASKINVERKEN AB, Kallhall. Tel.: Staket 0758/501.20, T.A.: Maskinverken Stockholm.
Associate Companies: Sunrod, Ltd., St. Mary Cray, Kent; Sunrod Manufacturing Corp., 595 Fifth Avenue, New York 17, U.S.A.
Boiler manufacture.

MELLERSTA och NORRA SVERIGES ANGPANNEFORENING (The Swedish Steam Users' Assocn.), Box 783, Stockholm 1. Tel.: 010-234600. T.A.: Angpanna Stockholm.
Inspection and consultation in power and heat.

AB SVENSKA METALLVERKEN, Skultuna. Tel.: Västeras 70120. T.A.: Essem Skultuna.
Boiler manufacture, general fabrication.
Installation of aluminium components such as: reactor vessels, pool liners, heat exchangers, storage tanks, reactor outlets, chopper tubes, graphite honeycombs, piping systems, decay tanks, to AB Atomenergi, Reactor Centrum Nederland, Centre d'Etude de l'Energie Nucleaire (CEN) as subcontractor to Fabricom, Belgium.

NAUMBURGS INDUSTRI AB, Sveavagen 53, Stockholm. Tel.: 23.00.80. T.A.: Naumburgind.
Loops for testing of material for reactors, fuel elements, heat exchangers, etc., all pipes for R3/Adam to ASEA, AB Atomenergi, Kgl Vattenfallsstyrelsen.

NORDARMATUR (AB Nordiska Armaturfabrikerna), Linkoping. Tel.: 29060. T.A.: Nordarmatur Linköping.
General fabrication, instrumentation.
Valves for Studsvik, R3/Adam Farsta, Risö, Denmark to AB Atomenergi ASEA and Dansk Atomenergikommission.

NORD VARME AND VENTILATIONS AB, Post Box 5140, Goteborg 5, Gotebergsvagen 52, Molndal. Tel.: 031/275040. T.A.: Värmebolaget Göteborg.
Associate Companies: ASEA, Västeras, Kungl. Vattenfallsstyrelsen and AB Atomenergi, Stockholm.
Pipework.
Main coolant system, purification system, subcoolant systems, waste products systems and all pipeworks in the station in austenitic and carbon steel materials to R3/Adam, Ågesta, to ASEA, Västeras, Kungl. Vattenfallsstyrelsen (KVS), Stockholm.

SVENSKA AB PHILIPS, Gavlegatan 16, Stockholm. Tel.: 349500. T.A.: Philamp.
Instrumentation.
Entire instrumentation for material test reactor R2, for Allis-Chalmers and AB Atomenergi; nuclear instruments for R2-0 to ASEA and AB Atomenergi; all instrumentation for zero energy bare reactor assembly to Kockums and AB Atomenergi.

REDERI AB NORDSTJERNAN, Atomic Power Group, Nynashamn. Tel.: 0752/13260. T.A.: Johnsons Stockholm.
Associate Companies: AB Motala Verkstad, Motala; Avesta Jernverks AB Avesta; AB Karlstads Mekaniska Werkstad, Karlstad.
Boiler manufacture, general fabrication.
Primary cooling circuit for R3/Adam to AB Atomenergi; dished end of reactor tank for Halden boiling water reactor to Institutt for Atomenergi; dished end and flanges of reactor tank for CEN to Eurochemique, Mol; dished end and casing of main heat exchanger for R3/Adam to Jönköpings Mek. Werkstad; tube elements for Risö to Danska Atomenergikommissionen.

AB ROSENBLADS PATENTER, Kommendorsgatan 16, Stockholm. 5 Tel.: 010.630480. T.A.: Calorspiral Stockholm.
Associate Companies: Toca Apparatebau GmbH (22c) Düren (Rhld), Germany; American Heat Reclaiming Corporation, New York; Rosenblad Corporation, New York.
D_2O and H_2O coolers in aluminium for reactor RO, Studsvik to AB Atomenergi; H_2O and CO_2 coolers in alclad, D_2O cooler in stainless steel for reactor R2, Studsvik to Allis Chalmers for AB Atomenergi; steam generators cooling D_2O in stainless steel for reactor R3, Ågesta to AB Atomenergi; steam generator cooling D_2O in stainless steel for OEEC Halden reactor project to Institutt for Atomenergi, Halden, Norway.

SANDVIKENS JERNVERKS AB, Sandviken. Tel.: 54111. T.A.: Steelworks Sandvikenswed.
Associate Company: Fabriks AB, Sandviken, Sweden.
Specialist materials.
Heat exchanger tubes for research reactor in Denmark (Head Wrightson Processes); tubings for reactor installation (Sofina, Belgium); tubings and manipulated tubing for reactor installation to Institutt for Atomenergi, Halden and Kjeller, Norway; tubings for R1 to AB Atomenergi; tubings for R2 to Atomenergi; tubings and manipulated tubing for R3/Adam to Svenska Elektriska AB ASEA, Västeras; heat exchanger tubes for R3/Adam to AB Atomenergi.

Sweden (Contd.)

SCIENTA, AB, Goteborg, Box 366. Tel.: 23.93.11. T.A.: Scientalab.
Light electrical, precision mechanisms, instrumentation.
Health monitor system to CERN, Div. STS, Geneva; gamma discriminator to AB Atomenergi; portable radiation meters to Swedish Armed Forces.

AB SKOGLUND AND OLSON, Gavle. Tel.: 29360. T.A.: ABSO.
Associate Company: AB A. Ekströms, Maskinaffär, Stockholm.
Electrical preheaters for Studsvik to AB Atomenergi; electrical immersion heaters for steam boiler for R3/Adam.

UDDEHOLMS AB, Uddeholm. Tel.: Hagfors 11400. T.A.: Uddeholms Uddeholm.
Associate Company: Degerfors Järnverk, Degerfors.
Boiler manufacture, general fabrication and specialist materials.
Reactor pressure vessel, including stainless thermal shields, tubes and further components, total weight 320 tons for R3/Adam to AB Atomenergi; two main heat exchangers for R3/Adam to AB Rosenblads Patenter; pressurizer vessel for R3/Adam to ASEA Västeras; expansion tank for R3/Adam to ASEA; main heat exchanger components for Halden, Norway to AB Rosenblads Patenter; two steam accumulators for Ranstad Uranium Works, (AB Atomenergi).

Switzerland

ALUMINIUM S.A. MENZIKEN, Menziken. Tel.: 064/6.16.21. T.A.: Aluminium Menziken.
Heavy electrical, boiler manufacture.
Light metal tanks for research reactors, (Reactor AG Wurenlingen); light metal coil tubes for synchrocyclotron, Geneva (ACEC).

AMF OVERSEAS CORP., Avenue de l'Etang, Geneva. Tel.: 34.77.00. T.A.: Ammafoco Geneva.
Associate Company: American Machine and Foundry, Ltd., 961 Madison Avenue, New York, U.S.A.

BROWN, BOVERI AND CO., LTD., Baden. Tel.: 056/75151. T.A.: Brownboveri Badenschweiz.
Associate Companies: British Brown-Boveri, Ltd., London; Brown Boveri (Canada), Ltd., Montreal; Brown Boveri Corporation, New York; Brown Boveri and Cie AG., Mannheim-Kafertahl; Cie Electro-Mecanique, Paris; Tecnomasio Italiano Brown Boveri S.A., Milan.
Heavy and light electrical, general fabrication, precision mechanisms.
Power supply systems for proton-synchrotrons for Geneva (CERN) and Harwell (U.K. AEA); heavy water pumps, heat exchangers, control rod drives for DIORIT Würenlingen; hot laboratories installation for Saclay (CEA); high-temperature gas cooled reactor (pebble bed type) for AVR nuclear power station (under construction by AG BBC-Krupp) (AVR Group, Julich); turbo-alternators (under construction by Richardsons Westgarth, Hartlepool, Ltd.) for Trawsfynydd (CEGB).

BUSS, LTD., Basle, P.O. Box, Basle 2. Tel.: 81.54.41. T.A.: Bussag.
General fabrication.
Plants for hydrofluoric acid to AEC specifications.

CHARMILLES ENGINEERING WORKS, LTD., 109 Route de Lyon, Geneva. Tel.: 33.26.50. T.A.: Hydroturbo Geneva.
General fabrication, precision mechanisms.
D_2O canned motor pump and fuel element guides for DIORIT (Reaktor AG., Würenlingen).

DEMIERRE AND CIE. S.A., 5 Corraterie, Geneva. Tel.: 022/24.52.66. T.A.: Demierracier Geneva.
Agents for companies supplying nuclear grade metals and fuel elements.

EBAUCHES S.A., Departement Oscilloquartz, Brevards 16, Neuchatel. Tel.: 038/5.85.01. T.A.: Ebauches Neuchatel.
Light electrical, specialist materials.

ELECTRIC MINIATURE LAMP WORKS, LTD., 41 Amerbachstr., Basle 7. Tel.: 061/32.92.92. T.A.: Kleinlampen.
Light electrical.
Electrical miniature bulbs for lighting instruments or signals for CERN, Genève-Cointrin.

ELECTRO-WATT S.A., Talacker 16, Zurich 22. Tel.: 23.76.40. T.A.: Electrowatt Zurich.
Associate Company: Atomelectra, Ltd., Zurich.
Engineering services and supervision of construction for research reactors and associated facilities (Reaktor AG., Würenlingen).

EMA—ELEKTRO-MASCHINEN KG., Schultze and Co., Hirschhorn/Neckar. Tel.: 344. T.A.: EMA Hirschhorn/N.
Associate Company: Canadian EMA, Ontario.
Medium and high frequency induction heating equipment for melting, brazing and sintering, production of medium frequency motor generators, high frequency tube generators.

ESCHER-WYSS AG, Hardstr. 319, Zurich. Tel.: 42.01.20. T.A.: Escher-Wyss.
Heavy electrical, general fabrication, precision mechanisms.
Steam and gas turbines; fans; heat exchangers.

M. ESCHLER, Urania-Accessoires, Bdenerstr. 288/296, Zurich. Tel.: 230.230. T.A.: Uraniauto.
Precision mechanisms.
Special pumps (Reaktor AG., Würenlingen), Electro hydraulic servovalves in course of development for CERN, Geneva.

FAVAG S.A., Monruz 34, Neuchatel. Tel.: 038/5.66.01. T.A.: Favag Neuchatel.
Associate Company: Hasler S.A., Berne.
Electric clocks, (Reaktor AG., Würenlingen).

GEORG FISCHER A.G., Muhlenthalstr. 105, Schaffhausen. Tel.: 053/5.60.31. T.A.: Geofischer Schaffhausen.
Specialist materials.
Steel castings for steam turbines and valve chests, for Trawsfvnydd, (Richardsons Westgarth, Ltd., Hartlepool); steam turbine castings for the Japanese Atomic Power Company (G.E.C., Ltd., Erith); heat exchanger castings for a heavy water reactor (Reaktor AG., Würenlingen); stainless pump impeller and pump castings (Klein, Schanzlin and Becker, Frankenthal).

GRONINGER, LTD., Bruderholzstr. 10, Binningen-Basle. Tel.: Basle 061/38.28.38. T.A.: Groninger Binningen-Baselland.
Associate Companies: Metalwarenfabrik Zug; Verzinkerei Zug.
Manufacture of all aluminium goods and aluminium packing, tubes, husks, boxes, flasks.

USINES JEAN GALLAY S.A., Chemin Frank Thomas, Eaux-Vives-Geneva. Tel.: 022/36.33.80. T.A.: Metalgal Geneva.
General fabrication, specialist materials.
Vacuum tubes, racks, pick up electrodes, for synchrotron (CERN, Geneva).

EMILE HAEFELY AND CIE. S.A., Lehenmattstr. 353, Basle. Tel.: 41.18.17. T.A.: Micarta.
Heavy electrical.
Power supply for injector for proton synchrotron (Argonne National Laboratory, Lemont, Illinois); power supply for injector unit for proton synchrotron (CERN, Geneva); ion accelerator for Basle University; electron accelerator for Institut d'Optique Electrontechnique (CNRS) Toulouse; also several other accelerators.

HEIZMANN AND REGIS, Aarau, Kreuzplatz. Tel.: 064/2.42.72. T.A.: Rifa Aarau.
Light electrical.

LANDIS AND GYR S.A., Zug. Tel.: 042/42525. T.A.: Divisor Zug.
Instrumentation.
Monitoring equipment for the proton-synchrotron, (CERN, Geneva); air monitors for the Swedish-Swiss-Finnish expedition to the Arctic; nuclear instrumentation for DIORIT, Würenlingen.

ARTHUR D. LITTLE Inc., Todistr. 17, Zurich 2. Tel.: 27.23.95. T.A.: Adlittle Zurich.
Associate Company: Arthur D. Little Inc., Cambridge, Mass.
Research, engineering, management services.

LUKON PAUL LUSCHER, Taufflen b/Biel. Tel.: 032/7.35.45. T.A.: Lukon Taufflen.
Light electrical.
Immersion heaters, heating bars (Reaktor AG., Würenlingen).

METALLSCHLAUCHFABRIK AG., Kellerstr. 45, Lucern. Tel.: 041/3.31.33. T.A.: Metallschlauch.
Associate Companies: The Power Flexible Tubing Co., Ltd., London; Manufacture Metallurgique de la Jonchere, Paris; Metallschlauch-Fabrik Pforzheim; Compagnia Italiana Tubi Merallici Flessibili, Turin.
Specialist materials.
Bellows for heavy water valves for CERN (supplied to various countries); expansion joints for high pressure steam systems for various nuclear plants (England, France, Holland, Sweden, Switzerland).

METTLER, 19 Pelikanstr., Zurich.
Instrumentation.

MIKRON WORKS, LTD., Bienne. Tel.: 032/2.74.85. T.A.: Mikron Bienne.
Machine tools and tools for production of high precision gears.

OERLIKON ENGINEERING CO., Affolternstr. 52, Zurich 50. Tel.: 48.18.10. T.A.: Oerlik Zurich.
Associate Company: Societe Oerlikon, Ornans, Doubs.
Heavy electrical, specialist materials.
Power supply for Würenlingen (Reaktor AG); power supply for bending magnets and bubble chamber magnets for proton synchrotron (CERN, Geneva); circulators for BR 1 reactor, Mol.

PHILIPS AG., Edenstr. 20, P.O. Box, Zurich 27. Tel.: 25.86.10. T.A.: Argenta.
Parent Company: Philips, Eindhoven, Holland.
Instrumentation.
Philips instrument console and operator's desk for reactor R2 (AB Atomenergi, Studsvik, Sweden); instrument panels for Petten, Reactor Centrum Nederland, and the swimming pool experimental reactor, Technical University, Delft; instrumentation panel for measuring and recording fast neutron and Gamma radiation levels in the synchrocyclotron, Laboratoire de Physique Nucléaire, Orsay.

H. RUEGG AND CO., Bergstr. 3, Kusnacht-Zh. Tel.: 051/90.06.11. T.A.: Rugusar.
Precision mechanisms.
Vibration table with set of riddles for determination of the composition of sand and gravel for Reaktor AG., Würenlingen.

SAUTER, BACHMANN AND CIE., Zahnraderfabrik, Netstal Gl. Tel.: 058/5.14.44. T.A.: Zahnrader Netstal.
Precision mechanisms.
Worm gears for Reaktor AG., Würenlingen.

SECHERON WORKS CO., LTD., P.O. Box, Geneva 21. Tel.: 022/326750 T.A.: Electricite.
Associate Companies: Nouvelle Compagnie Generale Electrique "Nancy" S.A., Nancy; OCREN S.A., Naples; Sécheron Portugesa S.A.R.L., Porto.
Heavy electrical, precision mechanisms.
Various components for TRIGA reactors (General Atomic Division of General Dynamics Corp., San Diego); canned pump motor sets for DIORIT Reactor, Würenlingen (Swiss Federal Institute for Reactor Research—formerly Reactor S.A.); blower motors for Chinon I (EDF); calculation and design work for a boiling water reactor for projected nuclear power station at Lucens (ENUSA, Lausanne).

SWISS LOCOMOTIVE AND MACHINE WORKS, Zurcherstr. 41, Winterthur. Tel.: 8.55.11. T.A.: Locomotive Winterthur.
Heavy and light electrical, boiler manufacture, general fabrication.
Roots blowers for Rarconte; Atomic Energy Establishment, Bombay; Reactor AG., Würenlingen.

SWISS METALWORKS SELVE AND CO., Thun. Tel.: 2.38.21. T.A.: Metalworks Thun.
Specialist materials.
Electrolytic hollow copper bars for use in accelerator construction.

SPRECHER AND SCHUH AG., Switchgear Manufacturing Co., Aarau. Tel.: 064/2.33.23. T.A.: Fea.
Associate Company: Sprecher and Schuh G.m.b.H., Linz/Donau.
Heavy and light electrical.
Power supply and control plant for (CERN, Geneva); control plant and part of power supply plant for reactor DIORIT (Swiss Federal Institute for Reactor Research, Würenlingen); power distribution switchgear and control panels for research reactor, Caracas (IVNIC).

P. VOGEL AND CIE, Veyrier pres Geneve. Tel.: 36.35.60.
Light electrical, precision mechanisms, instrumentation.
Handling equipment, tongs, pipettes, containers for universities, laboratories, etc.

PROF. P. WILLEMS, Forschungsinstitut, Steinhofhalde 20-22, Lucern. Tel.: 041/33.0.66. T.A.: Forschungsinstitut.
Ultrasonic generators for non-destructive testing.

ZWAHLEN AND MAYR S.A., 16 Malley, Lausanne. Tel.: 021/24.81.52. T.A.: Zwamayr.

Continental Industries Review

2. CLASSIFIED SECTION

REACTORS AND CRITICAL ASSEMBLIES

Control rods and drives

BELGIUM
ACEC.
BEN.
Hanrez.
Metallurgie and Mécanique Nucléaires.
FRANCE
Sté. Alsacienne.
Atlantique.
Commission d'Instrumentation Nucléaire Française.
Cie des Compteurs.
Creusot.
Dynatom.
GAAA.
CAFL.
Metafram.
Mors.
Thomson-Houston.
CSF.
GERMANY
AEG.
Luftfahrt-Technik.
Nukem (rods).
Siemens and Halske.
Siemens Schuckertwerke.
Virus.
HOLLAND
Koopman.
ITALY
Eigenmann and Veronelli.
Fiat.
NORWAY
Kongsberg Vapenfabrik.
Michelsens Institutt.
Noratom.
SWEDEN
ASEA.
SWITZERLAND
AMF
Brown-Boveri.
Charmilles
Sécheron.

Experimental loops

AUSTRIA
Simmering-Graz-Pauker.
BELGIUM
BelgoNucléaire.
BEN.
Hanrez.
SERAI.
FRANCE
L'Air Liquide.
Sté. Alsacienne.
Alsthom.
Babcock and Wilcox.
Dynatom.
GAAA.
CAFL.
Loire-Normandie.
Rateau.
Siersatom.
SNECMA.
Socema.
Sogreah.
Techniques Nucléaires.
CSF.
GERMANY
Babcock and Wilcox.
Borsig.
Heraeus.
Siemens Schuckertwerke.
HOLLAND
Ned. Electrolasch.
Neratoom.
Rotterdam Dockyard Co.
Werkspoor.
ITALY
Fiat.
SORIN.
NORWAY
Noratom.
SWEDEN
ASEA.
Svenska Järnvägsverkstäderna.
Naumburgs Industri.
Nord Värme and Ventilations.
Rederi AB Nordstjernan.
SWITZERLAND
AMF.
Brown-Boveri.

Fuel elements

AUSTRIA
Austro-Chematom.
BELGIUM
BelgoNucléaire.
BEN.
Hoboken.
Metallurgie and Mécanique Nucléaires.
FRANCE
Sté. Alsacienne.
CICAF.
Dynatom.
Kuhlmann.
Pechiney.
Saint-Gobain
SEPI.
SICN.
SNECMA.
CSF.
GERMANY
CSF.
Nukem.
Vereinigte Deutsche Metallwerke.
ITALY
Eigenmann and Veronelli.
Fiat.
SORIN.
SWEDEN
ASEA.
Atomenergi.
SWITZERLAND
Aluminium S.A. Menziken (sections and tubes).
AMF
Demierre.

In-pile components

AUSTRIA
Siemens.
Simmering-Graz-Pauker.
BELGIUM
ABR.
BelgoNucléaire.
BEN.
FRANCE
Creusot.
Dynatom.
GAAA.
CAFL.
Loire-Normandie.
Sodern.
GERMANY
Agrob.
Borsig.
Siemens Schuckertwerke.
HOLLAND
Neratoom.
Rotterdam Dockyard Co.
ITALY
Eigenmann and Veronelli.
NORWAY
Noratom.
SWEDEN
ASEA.
Rederi AB Nordstjernan.
SWITZERLAND
AMF.
Fischer
Sécheron.

Nuclear grade coolants

BELGIUM
BEN.
Brouhon.
STEGU.
FRANCE
L'Air Liquide.
Kuhlmann.
Stein and Roubaix.
ITALY
Eigenmann and Veronelli.
Montecatini.
SORIN.
NORWAY
Noratom.
SWITZERLAND
AMF.

Nuclear grade graphite

BELGIUM
BEN.
STEGU.
FRANCE
Pechiney.
GERMANY
Kropfinühl-Ringsdorff.
Siemens-Plania.
Siemens Schuckertwerke.
ITALY
Eigenmann and Veronelli.
SORIN.
SWITZERLAND
AMF.

Nuclear grade metals

AUSTRIA
Bohler Bros.
BELGIUM
BEN.
Cockerill-Ougrée.
Hoboken.
Vieille Montagne.
FRANCE
Creusot.
Dynatom.
Kuhlmann.
CAFL.
Metafram.
Pechiney.
Saint-Gobain.
CSF.
Ugine.
GERMANY
CSF.
Heraeus.
Merck.
Nukem.
Vereinigte Deutsche Metallwerke.
ITALY
Eigenmann and Veronelli.
SORIN.
SWEDEN
Degerfors Järnverk.
Svenska Metallverken.
Sandvikens Jernkerks.
Uddeholms.
SWITZERLAND
AMF.
Demierre.

Pressure vessels

AUSTRIA
Simmering-Graz-Pauker.
BELGIUM
ABR.
ACEC.
BEN.
Brouhon.
Cockerill-Ougrée.
D'Hondt.
Hanrez.
Lefèvre
Mercantile Marine Eng. and Graving Docks.
STEGU.
FRANCE
Sté. Alsacienne.
Atlantique.
Babcock and Wilcox.
Creusot.
GAAA.
Cie. Industrielle de Travaux.
Libbrecht.
CAFL.
Loire-Normandie.
Méditerrannée.
Rateau.
GERMANY
Babcock and Wilcox.
Borsig.
Dinglerwerke.
Guttehoffnungshütte Sterkrade.
Heraeus.
Klöckner-Werke.
Klöckner-Werke-Georgsmarien.
Klönne.
MAN.
Mannesmann.
Phoenix-Rheinrohr.
Uhde.
Vereinigte Kesselwerke.
HOLLAND
Breda.
Koninklijke Machinefabriek.
Leidsche Apparatenfabriek.
Ned. Electrolasch.
Neratoom.
Rotterdam Dockyard Co.
Werkspoor.
ITALY
Ansaldo.
Breda.
Brescia.
Cantieri Riuinti dell'Adriatico.
OLMI.
Termomeccanica Italiana.
Terni.
Tosi.
NORWAY
Kvaerner Brug.
Noratom.

SWEDEN
ASEA.
Degerfors Järnverk.
Avesta Jernverks.
Svenska Järnvägsverkstäderua.
Jönköpings.
Svenska Metallverken.
Rederi AB Nordstjernan.
Uddeholms.
SWITZERLAND
AMF.

Reactors

BELGIUM
ACEC.
BelgoNucléaire.
BEN.
D'Hondt.
Mercantile Marine Eng. and Graving Docks.
DENMARK
Burmeister and Wain.
FRANCE
Sté. Alsacienne.
Babcock and Wilcox.
Dynatom.
Framatome
France-Atome
GAAA.
Hispano-Suiza.
Indatom
Loire-Normandie.
Rateau.
Saint-Gobain.
GERMANY
AEG.
Babcock and Wilcox.
Dinglerwerke.
Guttehoffnungshütte Sterkrade.
Interatom
Luftfahrt-Technik.
MAN.
Phoenix-Rheinrohr.
Siemens Schuckertwerke.
Vereinigte Kesselwerke.
Virus.
HOLLAND
Koopman.
Ned. Electrolasch.
ITALY
Agip Nucleare
Ansaldo.
Breda.
Brescia.
Cantieri Riuniti dell'Adriatico.
Eigenmann and Veronelli.
Fiat.
SORIN.
Tosi.
NORWAY
Kvaerner Brug.
Noratom.
SWEDEN
ASEA
Degerfors Järnverk.
Rederi AB Nordstjernan.
Uddeholms.
SWITZERLAND
AMF.
Brown-Boveri.

EXTERNAL CIRCUIT

Circulators

AUSTRIA
Simmering-Graz-Pauker.
BELGIUM
BEN.
Evence Coppée.
Neu.
FRANCE
Neu.
Rateau.
SNECMA.
Socema.
GERMANY
AEG.
Babcock and Wilcox.
Borsig.
Dürrwerke.
Guttehoffnungshütte Sterkrade
Luftfahrt-Technik.
Worthington.
HOLLAND
Neratoom.
ITALY
Cantieri Riuniti dell'Adriatico.
Montecatini.
NORWAY
Kvaerner Brug.
SWEDEN
Svenska Fläktfabriken.
SWITZERLAND
AMF.
Brown-Boveri.
Oerlikon.

Ducting

AUSTRIA
Simmering-Graz-Pauker.
BELGIUM
BEN.
Brouhon.
Evence Coppée.
Mercantile Marine Eng. and Graving Docks.
DENMARK
Burmeister and Wain.
FRANCE
Babcock and Wilcox.
Creusot.
Libbrecht.
CAFL.
SEPI.
GERMANY
Babcock and Wilcox
Borsig.
Dinglerwerke.
Dürrwerke.
Guttehoffnungshütte Sterkrade.
MAN.
HOLLAND
Breda.
Neratoom.
Werkspoor.
ITALY
Breda.
Cantieri Riuniti dell'Adriatico.
Casinghini Economizzatori Green.
Dalmine.
Montecatini.
OLMI.
Terni.
Tosi.
NORWAY
Kvaerner Brug.
Noratom.
SWEDEN
Avesta Jernverks.
Svenska Fläktfabriken.
Naumburgs Industri.
Rederi AB Nordstjernan.
SWITZERLAND
Aluminium S.A. Menziken.
AMF.

Expansion joints

BELGIUM
ABR.
BEN.
Brouhon.
Citar.
STEGU.
DENMARK
Burmeister and Wain.
FRANCE
SEPI.
GERMANY
Babcock and Wilcox.
Dinglerwerke.
Dürrwerke.
Industrie-Werke.
ITALY
Angst and Pfister.
Breda.
Cantieri Riuniti dell'Adriatico.
Dalmine.
Montecatini.
Terni.
Tosi.
NORWAY
Kvaerner Brug.
SWEDEN
Naumburgs Industri.
Rederi AB Nordstjernan.
SWITZERLAND
AMF.
Metallschlauchfabrik.

Pumps

BELGIUM
ACEC.
BEN.
Ensival.
Hydrobel.
Wanson.
FRANCE
Hispano-Suiza.
Jeumont.
Lumpp.
Rateau.
Socema.
CSF.
Vernay.
GERMANY
Atlas-Werke.
Balcke.
Dürrwerke.
Edwards Hochvakuum (vacuum).
Guttehoffnungshütte Sterkrade.
Halberg-Weise.
Klöckner-Humboldt-Deutz.
Labendorf.
Lewa.
Luftfahrt-Technik.
MAN.
Siemens Schuckertwerke.
Uhde.
Virus.
Walbersdorf Sondermaschinen.
Worthington.
HOLLAND
Koninkijke Machinefabriek.
Neratoom.
ITALY
Ansaldo-San Giorgio.
Cantieri Riuniti dell'Adriatico.
Montecatini.
Officine Galileo (vacuum)
Termomeccanica Italiana.
Tosi.
LIECHTENSTEIN
Balzers (vacuum).
NORWAY
Kvaerner Brug.
SWEDEN
Jönköpings.
De Laval Ljungström Turbine.
Naumburgs Industri.
SWITZERLAND
AMF.
Brown-Boveri.
Charmilles.
Eschler.
Sécheron.
Swiss Locomotive and Machine (vacuum).

Seals, packings

BELGIUM
BEN.
Citar.
Hydrobel.
STEGN.
FRANCE
Creusot.
Siersatom.
Socema.
GERMANY
Babcock and Wilcox.
Dürrwerke.
Merkel.
Worthington.
ITALY
Angst and Pfister.
Cantieri Riuniti dell'Adriatico.
Montecatini.
OLMI.
Tosi.
LIECHTENSTEIN.
Balzers.
NORWAY
Kvaerner Brug.
SWEDEN
Naumburgs Industri.
SWITZERLAND
AMF.

Thermal insulation

BELGIUM
BEN.
Fabricom.
Wanson.
DENMARK
Burmeister and Wain.
FRANCE
Méditerranée.
CSF.
GERMANY
Agrob
Babcock and Wilcox.
Dürrwerke.
ITALY
Angst and Pfister.
Cantieri Riuniti dell'Adriatico.
Montecatini.
NORWAY
Kvaerner Brug.
Noratom.
SWEDEN
Naumburgs Industri.
SWITZERLAND
AMF.

Tubes and pipework

AUSTRIA
Bohler Bros.

BELGIUM
ABR.
BEN.
Brouhon.
Carnoy-Vandensteen.
Citar.
Cockerill-Ougrée.
Degrément.
D'Hondt.
Evence Coppée.
Fabricom.
Hanrez.
Hydrobel.
Lefèvre.
Mercantile Marine Eng. and Graving Docks.
Sobecomin.
Toleries Gantoises.
DENMARK
Burmeister and Wain.
FRANCE
Atlantique.
Babcock and Wilcox.
Creusot.
Lacollonge
Libbrecht.
CAFL.
Loire-Normandie.
Lorraine-Escaut.
Méditerranée.
SEPI.
Techniques Nucléaires.
GERMANY
Babcock and Wilcox.
Borsig.
Dinglerwerke.
Dürrwerke.
Guttehoffnungshütte Sterkrade.
Mannesmann.
Phoenix-Rheinrohr.
Schnakenberg.
Vereinigte Economiser-Werke.
Vereinigte Kesselwerke.
Vereinigte Leichtmetall-Werke.
HOLLAND
Leidsche Apparatenfabriek.
Ned. Electrolasch.
Neratoom.
Werkspoor.
ITALY
Angst and Pfister.
Ansaldo.
Ansaldo-San Giorgio.
Breda.
Cantieri Riuniti dell'Adriatico.
Dalmine.
Montecatini.
Termomeccanica Italiana.
Terni.
Tosi.
NORWAY
Kvaerner Brug.
Noratom.
Thunes.
SWEDEN
Avesta Jeruverks
Degerfors Järuverk.
Svenska Maskinverken.
Svenska Metallverken.
Naumburgs Industri.
Nord Värme and Ventilations.
Rederi AB Nordstjernan.
Sandvikens Jeruverks.
Uddeholms.
SWITZERLAND
Aluminium S.A. Menziken.
AMF.
Eschler.
Metallschlauchfabrik.

Valves

AUSTRIA
Bohler Bros.

BELGIUM
ACEC.
BEN.
Citar.
Degrément.
Electro Appareils.
Hydrobel.
Lefèvre.
Sobecomin.

FRANCE
L'Air Liquide.
Atlantique.
Cie des Compteurs.
Hispano-Suiza.
CAFL.
Lumpp.
Méditerranée.
Rateau.
SEPI.
Siersatom.
Techniques Nucléaires.

GERMANY
Atlas-Werke.
Babcock and Wilcox.
Bopp and Reuther.
Borsig.
Dinglerwerke.
Edwards Hochvakuum.
Honeywell.
Industrie-Werke.
Uhde.
Worthington.

HOLLAND
Dikkers.

ITALY
Ansaldo-San Giorgio.
Cantieri Riuniti dell'Adriatico.
Montecatini.
OLMI.
Tosi.

LIECHTENSTEIN
Balzers.

NORWAY
Kvaerner Brug.
Noratom.

SWEDEN
Avesta Jeruverks.
Svenska Fläktfabriken.
Naumburgs Industri.
Nordarmatur.
Rederi AB Nordstjernan.

SWITZERLAND
AMF.
Brown-Boveri.
Eschler.
GERMANY
Babcock and Wilcox.
Balcke.
Borsig.
Gattys.
Keramchemie.
Kerntechnik.
Klöckner-Humboldt-Deutz.
Lewa.
Otto.
Samesreuther.
Sunvic Regler.
Wilke-Säurebau.
HOLLAND
Duper Waterreiniging.
Ned. Electrolasch.
Neratoom.
Van Hattum en Blankevoort.
ITALY
Breda.
Montecatini.
OLMI.
Pavone.
SORIN.
Termomeccanica Italiana.
Tosi.
NORWAY
Noratom.
SWEDEN
Nord Värme and Ventilations.
SWITZERLAND
AMF.

Gas and fume treatment

BELGIUM
BELCHIM.
BEN.
Evence Coppée.
Hanrez.
Lefèvre.
FRANCE
Cie des Compteurs.
Dynatom.
Metafram.
GERMANY
Babcock and Wilcox.
Borsig.
CEAG.
Delbag-Luftfilter.
Keramchemie.
Kerntechnik.
Linde's Eismachinen.
Wälischmiller.
ITALY
Breda.
Montecatini.
SORIN.
SWEDEN
Svenska Fläktfabriken.
Nord Värmt and Ventilations.
SWITZERLAND
AMF.
Eschler.

Special fabrications

BELGIUM
ABR.
BEN.
Hamon.
Hanrez.
Lebrun.
Lefèvre.
Mercantile Marine Eng. and Graving Docks.
FRANCE
Dynatom.
Kuhlmann.
CAFL.
Loire-Normandie.
Mors.
Rateau.
SNECMA.
Sogreah.
GERMANY
Babcock and Wilcox.
Borsig.
Gattys.
Kerntechnik.
Luwa.
MAN.
Uhde.
HOLLAND
Breda.
Koninkijke Machinefabriek.
Leidscht Apparatenfabriek.
Neratoom.
Werkspoor.
ITALY
Montecatini.
Officine Galileo.
NORWAY
Noratom.
SWEDEN
ASEA.
Svenska Fläktfabriken.
SWITZERLAND
AMF.

ANCILLARY PLANT

Chemical plant

BELGIUM
ABR.
BELCHIM.
BEN.
Degrément.
Lebrun.
Toleries Gantoises.
Wanson.
FRANCE
L'Air Liquide.
Dynatom.
Kuhlmann.
Libbrecht.
Saint-Gobain.
GERMANY
Borsig.
Dinglerwerke.
Keramchemie.
Kerntechnik.
Lewa.
Linde's Eismachinen.
Nukem.
Präzisionsmessgeräte Ritzl and Seitner.
Uhde.
Wälischmiller.
Wilke-Säurebau.
HOLLAND
Koninkijke Machinefabriek.
Neratoom.
Rotterdam Dockyard Co.
ITALY
Montecatini.
SORIN.
NORWAY
Noratom.
SWITZERLAND
Buss.

Effluent water treatment

BELGIUM
BELCHIM.
BEN.
Degrément.
Evence Coppée.
Overpelt-Lommel.
Sobelco.

DENMARK
Elsinore.

FRANCE
Cie des Compteurs.
Lacollonge.
Metafram.
Saint-Gobain.
SEPI.
Sogreah.
Stein and Roubaix.

Ventilation plant

AUSTRIA
- Simmering-Graz-Pauker.

BELGIUM
- BELCHIM.
- BEN.
- Electro Appareits.
- Evence Coppée.
- Fabricom.
- Hanrez.
- Neu.
- Wanson.

FRANCE
- Méditerranée.
- Neu.
- Rateau.
- Saint-Gobain.
- SNECMA.
- Tunizi.

GERMANY
- Babcock and Wilcox.
- Bopp and Reuther.
- Borsig.
- Dinglerwerke.
- Drägerwerk.
- Escher Wyss.
- Kerntechnik.
- Krantz.
- Luwa.
- MAN.
- Schilde.
- Schnakenberg.
- Wälischmiller.

ITALY
- Ansaldo-San Giorgio.
- Montecatini.
- SORIN.

NORWAY
- Noratom.
- Theodor Qviller.

SWEDEN
- ASEA.
- Svenska Fläktfabriken.

SWITZERLAND
- AMF.

REMOTE HANDLING

Laboratory design

BELGIUM
- BELCHIM.
- BelgoNucléaire.
- BEN.

FRANCE
- Dynatom.
- Jouan.
- Saint-Gobain.
- SFIM.
- Siersatom.
- Socema.
- CSF.

GERMANY
- Antitron.
- Babcock and Wilcox.
- Brindi.
- Buchler.
- Donges Stahlbau.
- Fernsteuergeräte.
- Heraeus.
- Isotopen-Lab.
- Kerntechnik.
- Poetschke.
- Radium-Chemie.
- Schnakenberg.
- Siemens and Halske.
- Sunvic Regler.
- Virus.
- Wälischmiller.

HOLLAND
- Royal Neths. Lead and Zinc Rolling Mills.

ITALY
- Carem.
- Pavone.
- SORIN.

NORWAY
- Noratom.

SWEDEN
- Scienta.

SWITZERLAND
- AMF.
- Ebauches.
- Little.
- Vogel.

Mechanisms

AUSTRIA
- Simmering-Graz-Pauker.

BELGIUM
- BEN.
- Hanrez.
- Hydrobel.
- Mercantile Marine Eng. and Graving Docks.

DENMARK
- Frichs.

FRANCE
- Babcock and Wilcox.
- Creusot.
- Dynatom.
- GAAA.
- Hispano-Suiza.
- CAFL.
- Méditerranée.
- Mors.
- Saint-Gobain.
- Siersatom.
- Socema.
- CSF.

GERMANY
- Brindi.
- Donges Stahlbau.
- Heraeus.
- Kerntechnik.
- Lewa.
- Radium-Chemie.
- Siemens Schuckertwerke.
- Sunvic Regler.
- Virus.
- Wälischmiller.

HOLLAND
- Ned. Electrolasch.
- RTD.
- Royal Neths. Lead and Zinc Rolling Mills.

ITALY
- Eigenmann and Veronelli.
- Fiat.
- Pavone.
- Tosi.

NORWAY
- Noratom.
- Scienta.

SWITZERLAND
- AMF.
- Eschler.
- Sauter, Bachmann (gears).
- Sécheron.
- Vogel.

Protective clothing

BELGIUM
- BEN.
- Wanson.

FRANCE
- L'Air Liquide.
- Jouan.
- Saint-Gobain.
- Siersatom.

GERMANY
- Antitron.
- Poetschke.
- Virus.
- Wälischmiller.

ITALY
- Eigenmann and Veronelli.

Shielding blocks

AUSTRIA
- Bohler Bros.

BELGIUM
- BEN.
- Overpelt-Lommel.
- Vieille Montagne.

FRANCE
- Dynatom.
- Cie Industrielle de Travaux.
- Kuhlmann.
- CAFL.
- Loire-Normandie.
- Saint-Gobain.
- Siersatom.

GERMANY
- Agrob.
- Ambrosius.
- Antitron.
- Babcock and Wilcox.
- Borsig.
- Buchler.
- Ffank and Schulte.
- Hochtief.
- Isotopen-Lab.
- Jenaer Glaswerk.
- Klöckner-Werke.
- Poetschke.
- Radium-Chemie.
- Schnakenberg.
- Siemens and Halske.
- Sunvic Regler.
- Vereinigte Leichtmetall-Werke.
- Virus.
- Wälischmiller.

HOLLAND
- Kocken.
- Royal Neths. Lead and Zinc Rolling Mills.

ITALY
- Eigenmann and Veronelli.
- SORIN.

NORWAY
- Noratom.

SWITZERLAND
- AMF.
- Vogel.

Shielded containers

AUSTRIA
- Bohler Bros.
- Simmering-Graz-Pauker.

BELGIUM
- Balteau.
- BELCHIM.
- BelgoNucléaire.
- BEN.
- Contigea.
- Mercantile Marine Eng. and Graving Docks.
- Overpelt-Lommel.

DENMARK
- Burmeister and Wain.
- Elsinore.
- Frichs.

FRANCE
- Dynatom.
- Gamma Industrie.
- Jouan.
- Libbrecht.
- CAFL.
- Loire-Normandie.
- Saint-Gobain.
- Siersatom.
- Socema.
- Ugine.

GERMANY
- Agrob.
- Antitron.
- Babcock and Wilcox.
- Borsig.
- Buchler.
- Dinglerwerke.
- Gattys.
- Isotopen-Lab.
- Klöckner-Werke.
- Klöckner-Werke-Georgsmarien.
- MAN.
- Medizinische Technik Hoffmann.
- Phoenix-Rheinvohr.
- Poetschke.
- Radium-Chemie.
- Schnakenberg.
- Siemens Schuckertwerke.
- Sunvic Regler.
- Vereinigte Leichtmetall-Werke.
- Wälischmiller.

HOLLAND
- Kocken.
- Koopman.
- RTD.
- Royal Neths. Lead and Zinc Rolling Mills.

ITALY
- Eigenmann and Veronelli.
- Gilardoni.
- SORIN.
- Torin.
- Tosi.

NORWAY
- Noratom.

SWITZERLAND
- AMF.
- Vogel.

ELECTRICAL AND STEAM PLANT

Components

AUSTRIA
Bohler Bros.

BELGIUM
Brouhon.
Tudor.

DENMARK
Elsinore.

FRANCE
Alsthom.
Oerlikon.
Rateau.
SNECMA.
Socema.
Steafix.

GERMANY
AEG.
Babcock and Wilcox.
MAN.
Siemens Schuckertwerke.
Süddeutsche Kabelwerke.
Vereinigte Kesselwerke.

HOLLAND
Koopman.
Neratoom.

ITALY
Cantieri Riuniti dell'Adriatico.
CGE.
Dalmine.
Montecatini.
Pavone.
Sace.
SORIN.
Terni.
Tosi.

NORWAY
EGA.
Noratom.

SWEDEN
ASEA.
Degerfors Järnverk.
Naumburgs Industri.
Rederi AB Nordstjernan.
Uddeholms.

SWITZERLAND
Brown-Boveri.
Ebauches.
Fischer.
Heizmann and Regis.
Lukon Paul Luscher.
Sécheron.
Sprecher and Schuh.

Generators

AUSTRIA
Bohler Bros. (forgings).
Siemens.

BELGIUM
Brouhon.
Cockerill-Ougrée (turbines).
Wanson.

FRANCE
Alsthom.
Babcock and Wilcox.
Méditerranée.
Oerlikon.
Socema.

GERMANY
AEG.
MAN.
Siemens Schuckertwerke.
Vereinigte Kesselwerke.
Worthington.

ITALY
Ansaldo-San Giorgio.
Brescia.
Cantieri Riuniti dell'Adriatico.
CGE.
Dalmine (tubes).
Montecatini.
Officine Bossi.
Passoni and Villa.
Tosi.

NORWAY
Noratom.

SWEDEN
ASEA.
De Laval Ljungström Turbine.

SWITZERLAND
Brown-Boveri.
Ebauches.
EMA (high and medium frequency).
Oerlikon.
Sécheron.

Heat exchangers

AUSTRIA
Bohler Bros.
Simmering-Graz-Pauker.

BELGIUM
ABR.
BEN.
Brouhon.
Cockerill-Ougrée.
Degrément.
D'Hondt.
Evence Coppée.
Fabricon.
Hanrez.
Hydrobel.
Lebrun.
Lefèvre.
Sobelco.
Toleries Gantoises.
Wanson.

DENMARK
Burmeister and Wain.
Elsinore.

FRANCE
Atlantique.
Babcock and Wilcox.
Dynatom (design).
GAAA.
Jeumont.
Libbrecht.
CAFL.
Loire-Normandie.
Méditerranée.
SEPI.
SNECMA.
Socema.
Stein and Roubaix.

GERMANY
Babcock and Wilcox.
Balcke.
Borsig.
Dinglerwerke.
Dürrwerke.
Escher Wyss.
Gattys.
GEA.
Guttehoffnungshütte Sterkrade.
Klönne.
Kohlenscheidungs.
MAN.
Mannesmann.
Steinmüller.
Vereinigte Deutsche Metallwerke.
Vereinigte Economiser-Werke.
Vereinigte Kesselwerke.
Worthington.

HOLLAND
Breda.
Koopman.
Noratoom.
Rotterdam Dockyard Co.
Werkspoor.

ITALY
Agip Nucleare.
Ansaldo.
Breda.
Brescia.
Cantieri Riuniti dell'Adriatico.
Casinghini Economizzatori Green.
Montecatini.
Officine Bossi.
Termomeccanica Italiana.
Terni.
Tosi.

NORWAY
Kvaerner Brug.
Noratom.
Thunes.

SWEDEN
Avesta Jernverks.
Degerfors Järnverk.
Svenska Fläktfabriken.
Götaverken.
Svenska Järnvägsverkstäderna.
Jönköpings.
De Laval Ljungström Turbine.
Svenska Maskinverken.
Svenska Metallverken.
Rederi AB Nordstjernan.
Rosenblads.
Sandvikens Jernverks.
Uddeholms.

SWITZERLAND
Brown-Boveri.
Swiss Locomotive and Machine.

Stand-by supplies

AUSTRIA
Bohler Bros.
Simmering-Graz-Pauker.

DENMARK
Frichs.

FRANCE
Cie des Compteurs.
Jeumont.
Méditerranée.
Oerlikon.
Socema.

GERMANY
AEG.
Babcock and Wilcox.
Dürrwerke.
MAN.
Mannheim.
Phoenix-Rheinrohr.
Siemens Schuckertwerke.
Vereinigte Kesselwerke.

HOLLAND
Noratoom.

ITALY
Montecatini.
Terni.
Tosi.

NORWAY
Kvaerner Brug.
Noratom.

SWEDEN
ASEA.
Götaverken.

SWITZERLAND.
Brown-Boveri.
Sécheron.
Swiss Locomotive and Machine.
Vogel.

Steam plant

AUSTRIA
Siemens.
Simmering-Graz-Pauker.

BELGIUM
Brouhon.
Carnoy-Vandensteen.
Cockerill-Ougrée.
Fabricom.
STEGU.
Wanson.

DENMARK
Burmeister and Wain.

FRANCE
Creusot.
Jeumont.
Méditerranée.
Oerlikon.
Rateau.
Socema.
Stein and Roubaix.

GERMANY
AEG.
Babcock and Wilcox.
Balcke.
Borsig.
Dürrwerke.
Escher Wyss.
Fischer.
Kohlenscheidungs.
MAN.
Phoenix-Rheinrohr.
Siemens Schuckertwerke.
Steinmüller.
Vereinigte Kesselwerke.

HOLLAND
Neratoom.
Rotterdam Dockyard Co.
(for ship propulsion).
Werkspoor.

ITALY
Ansaldo.
Breda.
Cantieri Riuniti dell'Adriatico.
Dalmine (tubes).
Montecatini.
SORIN.

NORWAY
Kvaerner Brug.
Noratom.
Thunes.

SWEDEN
ASEA.
Götaverken.
Svenska Järnvägsverkstäderna.
Jönköpings.
De Laval Ljungström Turbine.
Svenska Maskinverken.
Rederi AB Nordst ernan.
Skoglund and Olson.

SWITZERLAND
Brown-Boveri.
Oerlikon.
Swiss Locomotive and Machine.

EXPERIMENT AND MEASUREMENT

Data handling

BELGIUM
- BelgoNucléaire.
- Bell Telephone.
- Electronic Associates.

FRANCE
- Sté. Alsacienne.
- Automatisme Electronique.
- COCEI.
- Commission d'Instrumentation Nucléaire Française.
- Cie des Compteurs.
- Dynatom.
- GAAA.
- Intertechnique.
- Meci.
- Rochar.
- SFIM.
- SNECMA.
- Sodern.
- CSF.

GERMANY
- AEG.
- Lab. Berthold.
- Brindi.
- CSF.
- Fernsteuergeräte.
- Hartmann and Braun.
- Honeywell.
- Isotopen-Lab.
- Luftfahrt-Technik.
- Poetschke.
- Siemens and Halske.
- Siemens Schuckertwerke.

ITALY
- CNEN.
- Fiat.
- Pavone.
- SORIN.

NORWAY
- Noratom.

SWEDEN
- Svenska AB Philips.
- Scienta.

SWITZERLAND
- AMF.
- Ebauches.
- Landis and Gyr.
- Little.
- Philips.

Irradiation Units

BELGIUM
- BelgoNucléaire.

FRANCE
- L'Air Liquide.
- Sté. Alsacienne.
- Commission d'Instrumentation Nucléaire Française.
- GAAA.
- Sogreah.
- CSF.

GERMANY
- Istopen-Lab.
- Poetschke.
- Sunvic Regler.
- Virus.

HOLLAND
- Koopman.

ITALY
- CNEN.
- Fiat.

NORWAY
- Noratom.

SWEDEN
- Svenska AB Philips.

SWITZERLAND
- AMF.
- Little.
- Philips.

Non-destructive test

BELGIUM
- Balteau.
- BelgoNucléaire.
- SERAI.
- Commission d'Instrumentation Nucléaire Française.

FRANCE
- Gamma Industrie.
- Jouan.
- Méditerranée.
- SNECMA.

GERMANY
- Babcock and Wilcox.
- Lab. Berthold.
- Buchler.
- Gattys.
- Herfurth.
- Isotopen-Lab.
- Poetschke.
- Virus.

HOLLAND
- RTD.

ITALY
- Ansaldo.
- CNEN.
- Gilardoni.
- Istituto di Richerche Breda.
- Pavone.
- SORIN.

NORWAY
- Kvaerner Brug.
- Noratom.

SWEDEN
- Svenska AB Philips

SWITZERLAND
- AMF.
- Landis and Gyr.
- Little.
- Philips.

Nuclear instrument

BELGIUM
- ACEC.
- Balteau.
- BelgoNucléaire.
- Bell Telephone.
- BEN.
- Contigea.
- Electro Appareils.
- MBLG.
- Physique Industrielle.

FRANCE
- Sté. Alsacienne.
- Commission d'Instrumentation Nucléaire Française.
- Constructions Electroniques du Centre.
- Cie des Compteurs.
- Dynatom.
- L'Electronique Appliquée.
- GAAA.
- Hispano-Suiza.
- Intertechnique.
- Jouan.
- Quartz and Silice.
- Radiotechnique.
- SAIP.
- Siersatom.
- Techniques Nucléaires.
- Thomson-Houston.
- CSF.

GERMANY
- AEG.
- Lab. Berthold.
- Brindi.
- Buchler.
- Frieske and Hoepfner.
- Graetz.
- Hartmann and Braun.
- Herfurth.
- Honeywell.
- Kirem.
- Knott.
- Luftfahrt-Technik.
- Medizinische Technik Hoffmann.
- Physikalisch-Techink Pychlau.
- Poetschke.
- Siemens and Halske.
- Siemens Schuckertwerke.
- Sunvic Regler.
- Virus.
- Worthington.

HOLLAND
- L'Electro-Navale et Industrielle.
- Koopman.
- Neratoom.

TALY
- CNEN.
- Fiat.
- Italettronica.
- Koristka.
- Laben.
- Lombarda.
- Pavone.

NORWAY
- Noratom.

SWEDEN
- Svenska AB Philips.
- Scienta.

SWITZERLAND
- AMF.
- Landis and Gyr.
- Philips.

Particle accelerators

BELGIUM
- ACEC.

FRANCE
- Alsthom.
- Commission d'Instrumentation Nucléaire Française.
- Creusot.
- Gamma Industrie.
- SAMES.
- Thomson-Houston.
- CSF.

GERMANY
- AEG.
- CSF.
- Edwards Hochvakuum (pumps).
- Siemens Schuckertwerke.

HOLLAND
- Koopman.
- Neratoom.

ITALY
- CNEN.
- Passoni and Villa.

SWEDEN
- Svenska AB Philips.

SWITZERLAND
- AMF.
- Brown-Boveri.
- Haefely.
- Philips.
- Swiss Metalworks Selve.

Process control

BELGIUM
- Bell Telephone.
- BEN.
- Electronic Associates.
- MBLG.

FRANCE
- Automatisme Electronique.
- COCEI.
- Commission d'Instrumentation Nucléaire Française.
- Cie des Compteurs.
- Controle Bailey.
- L'Electronique Appliquée.
- Intertechnique.
- Jeumont.
- Meci.
- Mors.
- Optique and Precision de Levallois.
- SFIM.
- Sodern.
- CSF.

GERMANY
- AEG.
- Atlas-Werke.
- Brindi.
- Fernsteuergeräte.
- Frieske and Hoepfner.
- Hartmann and Braun.
- Herfurth.
- Honeywell.
- Luftfahrt-Technik.
- Poetschke.
- Siemens and Halske.
- Uhde.
- Virus.

HOLLAND
- Breda.
- Koopman.

ITALY
- CNEN.
- Pavone.

NORWAY
- Michelsens Institutt.
- Noratom.

SWEDEN
- ASEA.
- Svenska AB Philips.
- Scienta.

SWITZERLAND
- AMF.
- Landis and Gyr.
- Little.
- Philips.

Test equipment

BELGIUM
- Balteau.
- Contigea.
- Electro appareils.

FRANCE
- Automatisme Electronique.
- Commission d'Instrumentation Nucléaire Française.
- Constructions Electroniques du Centre.
- Dynatom.
- GAAA.
- Jeumont.
- Jouan.
- Kuhlmann.
- Oerlikon.
- Quartz et Silice.
- SFIM.
- SNECMA.
- Sogreah.
- Thomson-Houston.
- CSF.

GERMANY
- AEG.
- Atlas-Werke.
- Babcock and Wilcox.
- Brindi.
- CSF.
- Edwards Hochvakuum (vacuum).
- Electrophysik.
- Frieske and Hoepfner.
- Hartmann and Braun.

Herfurth.
Isotopen-Lab.
Knott.
Luftfahrt-Technik.
Phoenix-Rheinrohr.
Poetschke.
Siemens and Halske.
Steinheil.
Sunvic Regler.
Virus.

HOLLAND
Koopman.
Neratoom.
RTD.

ITALY
CNEN.
Gilardoni.
Pavone.
SORIN.

NORWAY
Noratom.

SWEDEN
ASEA.
Svenska AB Philips.
Scienta.

SWITZERLAND
AMF.
Landis and Gyr.
Philips.

SPECIAL EQUIPMENT

Centrifuges

BELGIUM
Hanrez.

FRANCE
Hispano-Suiza.
Jouan.
Libbrecht.
Lumpp.
SNECMA.
Socema.

GERMANY
Escher Wyss.
Wälischmiller.

HOLLAND
Koopman.

ITALY
Ansaldo-San Giorgio.

SWITZERLAND
AMF.

Cranes and lifting gear

AUSTRIA
Simmering-Graz-Pauker.

BELGIUM
ABR.
BEN.

DENMARK
Frichs.

FRANCE
Applevage.
Babcock and Wilcox.
Creusot.
Jeumont.
CAFL.
Loire-Normandie.
Saint-Gobain.

GERMANY
Demag-Zug.
Donges Stahlbau.
Klönne.
MAN.
Wälischmiller.

HOLLAND
Interlas (lifting gear).
Neratoom.

ITALY
Ansaldo.
Ansaldo-San Giorgio.
Cantieri Riuniti dell'Adriatico.
Ceretti and Tanfani.
Terni.

NORWAY
Kvaerner Brug.
Noratom.

SWEDEN
ASEA.

SWITZERLAND
AMF.
Charmilles.

Furnaces

AUSTRIA
Simmering-Graz-Pauker.

BELGIUM
Hanrez.

DENMARK
Hasle Klinker.

FRANCE
Applications Electrothermiques.
Loire-Normandie.
Méditerranée.
SEPI.
Siersatom.
Stein and Roubaix.

GERMANY
AEG.
Babcock and Wilcox.
Borsig.
Dürrwerke.
Edwards Hodrvakuum (high vacuum).
Heraeus.
Nukem.
Uhde.
Virus.
Wälischmiller.

HOLLAND
Werkspoor.

ITALY
Cantieri Riuniti dell'Adriatico.
Eigenmann and Veronelli.
Pavone.

LIECHTENSTEIN
Balzers (vacuum).

NORWAY
Noratom.

SWEDEN
ASEA.

SWITZERLAND
Brown-Boveri (Electrical).

Hydraulic equipment

AUSTRIA
Simmering-Graz-Pauker.

BELGIUM
BEN.
Evence Coppée.
Hydrobel.
Mercantile Marine Eng. and Graving Docks.

FRANCE
Creusot.
Hispano-Suiza.
CAFL.
Loire-Normandie.
Saint-Gobain.
Walbersdorf Sondermaschinen.
Wälischmiller.

HOLLAND
Koopman.

ITALY
Cantieri Riuniti dell'Adriatico.
SORIN.
Tosi.

NORWAY
Kvaerner Brug.
Noratom.

SWEDEN
ASEA.

SWITZERLAND
AMF.
Charmilles.
Eschler.
Heizmann and Regis.

Pneumatic equipment

BELGIUM
BEN.
Evence Coppée.
Hydrobel.
Lebrun.
STEGU.

FRANCE
Hispano-Suiza.
Saint-Gobain.
Wälischmiller.
Worthington.

HOLLAND
Breda.

ITALY
Ansaldo-San Giorgio.
Cantieri Riuniti dell'Adriatico.
SORIN.
Tosi.

SWITZERLAND
AMF.
Charmilles.
Swiss Locomotive and Machine.

Welding and brazing

AUSTRIA
Simmering-Graz-Pauker.

BELGIUM
ABR.
BEN.
Fabricom.
Hanrez.
Mercantile Marine Eng. and Graving Docks.

DENMARK
Burmeister and Wain.

FRANCE
L'Air Liquide.
Alsthom.
Applications Electrothermiques.
Atlantique.
Babcock and Wilcox.
Creusot.
CAFL.
Méditerranée.
Mors.
SNECMA.

GERMANY
Donges Stahlbau.
Dürrwerke.
Edwards Hochvakuum (electron beam welding).
Klönne.
Linde's Eismaschinen.
MAN.
Nukem.
Phoenix-Rheinrohr (welding).
Siemens Schuckertwerke.
Vereinigte Kesselwerke.
Vereinigte Leichtmetall-Werke.
Worthington (welding equipment).

HOLLAND
Interlas.
Neratoom.

ITALY
Ansaldo.
Ansaldo-San Giorgio.
Breda.
Cantieri Riuniti dell'Adriatico.
Eigenmann and Veronelli.
OLMI.
Tosi.

NORWAY
Kvaerner Brug.
Noratom.

SWEDEN
ASEA.
Svenska Metallverken.
Naumburgs Industri.
Nord Värme and Ventilations.
Rederi AB Nordstjernan.

SWITZERLAND
AMF.
Brown-Boveri.
EMA (melting and brazing).
Heizmann and Regis.
Sécheron.

CONTRACTORS

Civil engineering

AUSTRIA
Simmering-Graz-Pauker.

BELGIUM
CFE.
Evence Coppée.

FRANCE
Sté. Alsacienne.
GAAA.
Hispano-Suiza.
Cie Industrielle de Travaux.
Loire-Normandie.
Razel Frères.
SNECMA.

GERMANY
Babcock and Wilcox.
BBC-Krupp.
Donges Stahlbau.
Grün and Bilfinger.
Hartmann and Braun.
Hochtief.
Kerntechnik.
Poetschke.
Uhde.
Virus.
Walbersdorf Sondermaschinen.

HOLLAND
Van Hatten en Blankevoort.

ITALY
Fiat.
Guffanti.
SORIN.
Torno.
Vitro Italiana.

NORWAY
Kvaerner Brug.
Noratom.

PORTUGAL
CPIN.

SWEDEN
Nord Värme and Ventilations.
Rederi AB Nordstjernan.

SWITZERLAND
AMF.
Electro-Watt.

Electrical

AUSTRIA
Siemens.
Simmering-Graz-Pauker.

BELGIUM
ACEC.
Electro Appareils.
Evence Coppée.
Fabricom.
FRANCE
Alsthom.
COCEI.
Jeumont.
Mors.
Oerlikon.
Socema.
Thomson-Houston.
GERMANY
AEG.
Kerntechnik.
Siemens Schuckertwerke.
Uhde.
Vereinigte Leichtmetall-Werke.
Virus.
HOLLAND
L'Electro-Navale et Industrielle.
Neratoom.
ITALY
CGE.
Pistorelli.
SORIN.
Vitro Italiana.
NORWAY
EGA.
Noratom.
PORTUGAL
CPIN.
SWITZERLAND
AMF.
Brown-Boveri.
Electro-Watt.
Oerlikon.
Sécheron.
Sprecher and Schuh.

Light alloy fab.

AUSTRIA
Simmering-Graz-Pauker.
BELGIUM
D'Hondt.
Mercantile Marine Eng. and Graving Docks.
FRANCE
Atlantique.
Dynatom.
CAFL.
SNECMA.
GERMANY
Babcock and Wilcox.
Dürrwerke.
Vereinigte Deutsche Metallwerke.
Vereinigte Leichtmetall-Werke.
HOLLAND
Werkspoor.
ITALY
Cantieri Riuniti dell'Adriatico.
Montecatini.
SORIN.
NORWAY
Noratom.
SWEDEN
Svenska Metallverken.
SWITZERLAND
Aluminium S.A. Menziken.
AMF.
Electric Min. Lamp Works.
Groninger.

Nuclear consultants

AUSTRIA
Simmering-Graz-Pauker.
BELGIUM
ACEC.
BelgoNucléaire.
BEN.
SERAI.
FRANCE
Sté. Alsacienne.
Alsthom.
Dynatom.
GAAA.
Kuhlmann.
Mors.
Saint-Gobain.
GERMANY
AEG.
BBC-Krupp.
Gattys.
Kerntechnik.
Kirem.
Nukem.
Poetschke.
Siemens Schuckertwerke.
Sunvic Regler.
Virus.
Wälischmiller.
Worthington.
HOLLAND
Koopman.
ITALY
Fiat.
Montecatini.
SORIN.
Vitro Italiana.
NORWAY
Kvaerner Brug.
Noratom.
PORTUGAL
CPIN.
SWITZERLAND
AMF.
Brown-Boveri.
Electro-Watt.
Little.

Steel fabrications

AUSTRIA
Bohler Bros.
Simmering-Graz-Pauker.
BELGIUM
Brouhon.
Cockerill-Ougrée.
D'Hondt.
Evence Coppée.
Fabricom.
Hanrez.
Henricot.
Jambes-Namur.
Lebrun.
Lefèvre.
Mercantile Marine Eng. and Graving Docks.
Overpelt-Lommel.
STEGU.
DENMARK
Burmeister and Wain.
Frichs.
FRANCE
L'Air Liquide.
Atlantique.
Creusot.
CAFL.
Lorraine-Escant.
GERMANY
Borsig.
Dinglerwerke.
Donges Stahlbau.
Dürrwerke.
Klöckner-Werke.
Klöckner-Werke-Georgsmarien.
Klönne.
Phœnix-Rheinrohr.
Röchling'sche Eisen u. Stahlwerke.
Vereinigte Kesselwerke.
Virus.
HOLLAND
Koninkijke Machinefabriek.
Werkspoor.
ITALY
Ansaldo.
Breda.
Cantieri Riuniti dell'Adriatico.
Dalmine.
Fiat.
Terni.
Tosi.
NORWAY
Kvaerner Brug.
Noratom.
SWEDEN
ASEA.
Avesta Jernverks.
Rederi AB Nordstjernan.
SWITZERLAND
AMF.

Structural Steel

AUSTRIA
Simmering-Graz-Pauker.
BELGIUM
Brouhon.
Cockerill-Ougrée.
Evence Coppée.
Fabricom.
Jambes-Namur.
Lefèvre.
Mercantile Marine Eng. and Graving Docks.
DENMARK
Burmeister and Wain.
FRANCE
Creusot.
Jeumont.
CAFL.
Lorraine-Escant.
Méditerranée.
GERMANY
Borsig.
Dinglerwerke.
Donges Stahlbau.
Dürrwerke.
Klöckner-Humboldt-Deutz.
Klöckner-Werke.
Klöckner-Werke-Georgsmarien.
Klönne.
Mannesmann.
Phoenix-Rheinrohr.
Röchling'sche Eisen u. Stahlwerke.
Uhde.
Vereinigte Kesselwerke.
Virus.
HOLLAND
Koninkijke Machinefabriek.
Werkspoor.
ITALY
Breda.
Dalmine.
Officine Bossi.
Terni.
Tosi.
NORWAY
Kvaerner Brug.
Noratom.
SWEDEN
Rederi AB Nordstjernan.
SWITZERLAND
AMF.

NUCLEAR PRODUCTS AND SERVICES LISTED

REACTORS AND CRITICAL ASSEMBLIES	EXTERNAL CIRCUIT	ANCILLARY PLANT	REMOTE HANDLING
Control rods and drives Experimental loops Fuel elements In-pile components Nuclear grade coolants Nuclear grade graphite Nuclear grade metals Pressure vessels Reactors	Circulators Ducting Expansion joints Pumps Seals, packings Thermal insulation Tubes and pipework Valves	Chemical plant Effluent, water treatment Gas and fume treatment Special fabrications Ventilation plant	Laboratory design Mechanisms Protective clothing Shielding blocks Shielded containers
ELECTRICAL AND STEAM PLANT	**EXPERIMENT AND MEASUREMENT**	**SPECIAL EQUIPMENT**	**CONTRACTORS**
Components Generators Heat exchangers Stand-by supplies Steam plant	Data handling Irradiation units Non-destructive test Nuclear instruments Particle accelerators Process control Test equipment	Centrifuges Cranes and lifting gear Furnaces Hydraulic equipment Pneumatic equipment Welding and brazing	Civil engineering Electrical Light alloy fab. Nuclear consultants Steel fabrications Structural steel

Industrial Notes

David Brown Industries is one of six member companies of International Shielding Industries, a group formed for the purpose of undertaking consulting, design, engineering, fabrication, construction and, in some cases, maintenance of shielding against corrosives, radiation and radioactive corrosives. Other members of the group are Canadian Vickers, Robatel et Mulatier (France), Officine Ing. Demicheliss (Italy), Knapp Mills (U.S.A.), and Pacific Coast Engineering (U.S.A.). It is expected that companies from Australia, Germany, India, Japan, South Africa and South America will join the group, in addition to further companies from the States.

General Electric, of England, have concluded a long term agreement with **Nippon Denkyoku Kabushiki Kaisha,** of Japan, covering the manufacture in Japan of graphite developed by G.E.C. for use in nuclear plant. G.E.C. will supply all information available on the processes involved and will assist the Japanese company to set up the necessary manufacturing plant. They will also provide technical staff for building the plant and will undertake to train Japanese engineers. In return G.E.C. will receive a capital sum of £50,000 and royalties on all sales. The Japanese company will be able to sell their graphite anywhere in the world except Britain.

Oak Ridge National Laboratory shipped 3,927 curies of radioisotopes during September, bringing the total 1960 shipments to 155,062 curies.

Pye Industries, of Australia, and **Petbow,** of England, have formed an Australian company, Petbow Pty., for the manufacture of Petbow equipment.

Kaiser Aluminum and Chemical earned $5,802,000 during the quarter ended September 30, 1960, compared with $2,014,000 in the same period last year.

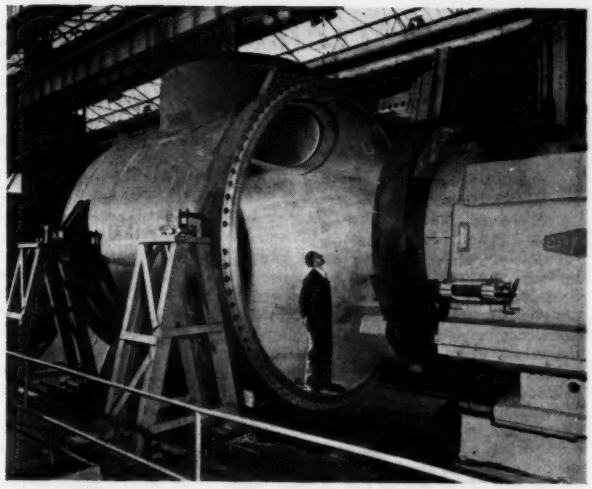
Associated Electrical Industries (Instrumentation Division) are to supply two MS7 spark-source mass spectrometers to Russia for £50,000.

Spencer Chemical Company are to supply the ceramic grade uranium dioxide to be used for fuel element fabrication in the first partial Dresden reload.

Nuclear Enterprises (G.B.) have received an order from Kernreaktor, Karlsruhe, Germany, for a human body monitor, the first to be supplied by the company to the Continent.

Dowty Technical Developments has been formed to undertake advanced project work for the Dowty Group. Headquarters are at Brockhampton Park, Andoversford, Gloucs.

American Standard have received a contract from Euratom for research on the use of ultrasonic vibrations to increase permissible heat transfer rates in nuclear equipment using boiling liquids.



The flange of a CO_2 blower vessel for the 500 MW Hinkley Point nuclear power station being machined at the English Electric's Netherton Works.

Quickfit and Quartz apparatus is now being produced to the revised British Standard for conical ground-glass joints. This is to bring it into line with the new international standards.

Tracerlab have acquired the interests of the Belgian firm Physique Industrielle S.A. The company intends to build manufacturing facilities at Mechlen, mid-way between Antwerp and Brussels.

Hawker Siddeley Nuclear Power, a member of the Hawker Siddeley Group, and Spembly, a member of the Harper Group, are to co-operate on the design, manufacture and selling of specialized high temperature furnaces.

Metal Industries, having acquired the share capital of Godfrey Electrical Industries Pty., of Sydney, have amalgamated the company with their subsidiary Lancashire Dynamo Coates, Melbourne, and formed a new company, M.I. Australia.

International Combustion (Holdings) and **Simon-Carves** have decided to merge their technical facilities and resources and collaborate on large projects. It is not intended that any merging of capital or financial resources should take place.

Honeywell Controls are to extend their factory at Motherwell, Lanarkshire, by 160,000 sq. ft. Total floor space of the factory when the extension is completed in three years' time will be 350.000 sq. ft. Labour force will be 3,000, compared with the current 2,000.

Mallinckrodt Chemical Works are to supply Combustion Engineering with 4,350 lb of uranium oxide enriched to 3.41% U^{235} for use in the NUSU (Nuclear Superheat) and BONUS (Boiling Nuclear Superheat) critical experiments related to the Puerto Rican reactor project.

Ebasco Services, New York, have been engaged by the USAEC to provide architect-engineering services in connection with the advanced test reactor planned for installation at the Idaho Falls National Reactor Testing Station. Construction of the reactor is scheduled to start in March, 1961, and a constructor contractor has yet to be selected.

Armstrong Whitworth Equipment have installed at the National Gas Turbine Establishment, Pyestock, equipment for the remote control of high precision machining operations. The equipment, the basis of which is an electro-hydraulic servo valve, would enable operations to be carried out miles from the control panel, the operations being viewed by the operator by means of television.

The British Oxygen Company has resumed trading under its own name and from December 31, 1960, the subsidiary companies, British Oxygen Gases, British Oxygen Engineering, British Oxygen Research and Development, Quasi-Arc, Sparklets and Charles King will cease to operate. Their functions will then be taken over by the parent company which will be split up into various divisions—operating, technical, sales, engineering, scientific, chemicals and overseas.

Negretti and Zambra have opened new premises at 38 Dean Street, Newcastle upon Tyne. Telephone 20420.

Electric Remote Control have started production in the 14,500 sq. ft extension to their factory at Harlow, Essex.

The telephone number of **Turner Brothers Asbestos** at 14 Finsbury Circus, London, E.C.2, is now LONdon Wall 5471.

Birfield have moved their head office to 20 Hill Street, London, W.1. Telephone number remains GROsvenor 7090.

Telephone numbers of the Forging Division of **High Duty Alloys** are now Redditch 4211 (day) and Redditch 4162 (night).

Winston Electronics have received orders for their beryllium monitor from the United States, France and Japan valued at £15,000.

Tube Investments made a net profit during the year ended July 31, 1960, of £8,100,000, compared with £6,458,460 in the previous year.

Dowty Nucleonics have changed their name to Dowty Electrics. The company will continue to operate from Tewkesbury, Gloucs.

Technical Papers and Publications

THE INSTITUTION OF STRUCTURAL ENGINEERS

(Joint Meeting with the Societe des Ingenieurs Civils de France (British Section))

Prestressed Concrete Pressure Vessels at Marcoule Nuclear Centre. By Jean Bellier and Max Tourasse.

Frequent references have been made to the use of prestressed concrete in the gas-cooled reactors G2 and G3; a general description appeared in *Nuclear Engineering* for December, 1959, p. 435. In this paper, the vessels are described in detail from the point of view of design by M. Bellier (Consulting Engineer) and from that of the actual construction, by M. Tourasse (Director, Compagnie Industrielle de Travaux).

In order to get a clear picture of the magnitude of the task, it may be as well to recall some of the leading dimensions. Each of the vessels is, in effect, a horizontal cylinder 20 m (65 ft 8 in.) external diameter and 33.6 m (110 ft) overall length, with a wall thickness of 3 m (9 ft 10 in.). The interior is not truly cylindrical throughout, the lower portion being filled in to form a V-shaped bed for the core supports. The ends are internally domed, to function in compression, as would be expected with a concrete structure. The net internal volume is 3,000 m³ (105,800 ft³) and the total load on the foundations, some 75,000 tons. Since the possibility of gas-tightness was somewhat remote with a structure of this magnitude, a steel liner, 30 mm (1.18 in.) thick, was provided.

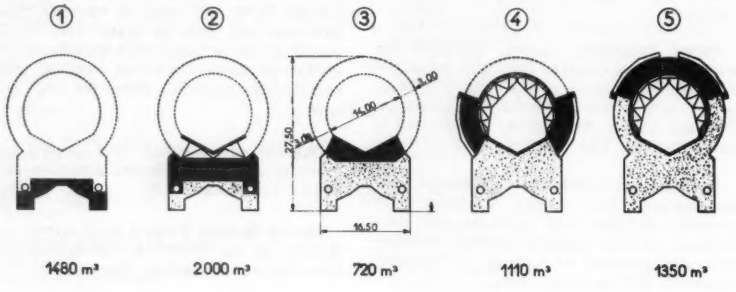
Prestressing is provided by three separate cable systems; longitudinal (46), transverse (56) and hoop tendons (57), and it is interesting to note that the forces to be resisted under pressure fell more into the category met with in the design of large dams rather than ordinary civil engineering structures, the forces acting on the ends of the vessel alone approximating six or seven times the weight of the Eiffel Tower.

The account given of the design is of considerable general interest, instead of being (as it might well have been) an indigestible mass of mathematics, and the author is refreshingly candid in his review, pointing out that many decisions which had to be made inconveniently early would now permit of more elegant solutions; bearing in mind the time factor, and the necessity of preventing delays in enabling other design work to proceed, there was frequently no alternative but to play for safety and, when in doubt, under-rate the allowable stresses. An outstanding example of this was in the design of the hoop tendons. These were placed outside the concrete, and enclose some 250° of the circumference of the vessel. Since they were to be tensioned from one end only, friction—even with sliding bearing plates between the cables and the concrete—would cause a considerable loss in tension. The coefficient of friction originally selected was 0.2, since it was not thought practicable to consider the bearing plates as being lubricated owing to the high bearing pressures. With this figure, some 60% tension would be lost between live and dead ends, although the overall effect could be brought down to about 35% by tensioning alternate hoops from the other end. In the event, the use of spheroidal graphite cast iron, highly finished and sulphonized by the Partiot process, and lubricated with molybdenum disulphide, gave a coefficient of friction which was nearer 0.02.

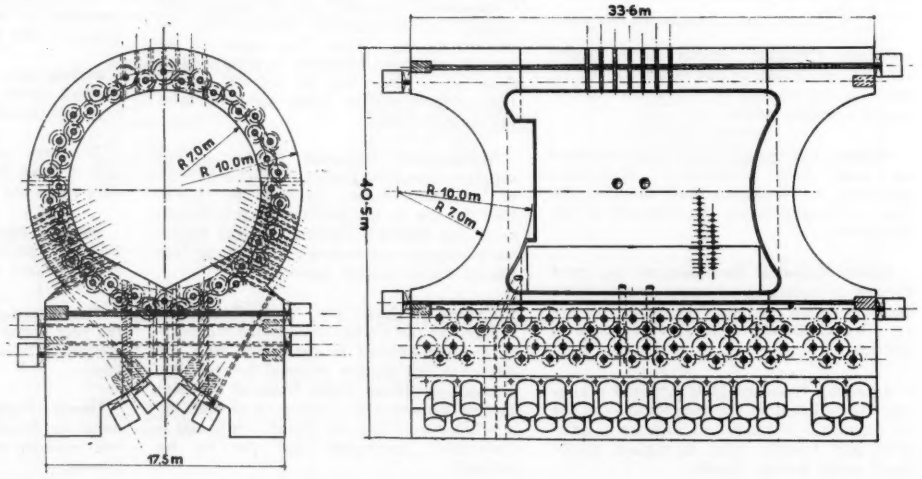
The second part of the paper gives a very interesting factual account of the site arrangements and construction methods for carrying out this considerable task, not the least of which were the arrangement of "lifts" for concrete pouring, and the making-up of the cables. The concrete arrangements are illustrated; the total amount of concrete was 6,660 m³ (8,710 yd³).

Site fabrication of the cables was essential owing to their weight (up to 123 kg/m or about 83 lb/ft), their restricted bending (min. radius 3 m or 9 ft 10½ in.) and the number of wires in each cable (715 or 797). The total amount of wire for the two reactors was some 10,000 km (6,210 miles). Of particular interest were the methods adopted for installing the cables and, in the case of the hoop tendons, the arrangements for pre-twisting the cables.

Publication of this paper has been undertaken by the Cement and Concrete Association.



(Above) Construction stages of the G2 and G3 pressure vessels; solid black and figures show the disposition, and amount, of concrete poured at each stage.



(Right) Simplified arrangement of pressure vessel, showing the three reinforcement systems.

THE INSTITUTION OF MECHANICAL ENGINEERS

Inspection of primary circuits and reactor pressure vessels of nuclear power plant. By H. N. Pemberton, M.I.Mech.E., and E. Crossley, M.I.Mech.E.

"Inspection commences on the drawing board" could be said to be the central theme of this paper. The authors, both of whom are connected with Lloyd's Register, make it very clear that the term "inspection" is here used in a much wider sense than its normally accepted usage, and involves

all phases of design and manufacture. A moment's thought will show that this is, in fact, the only possible point of view, bearing in mind that a steam boiler is normally subject to annual inspection, while the pressure parts of a nuclear reactor—the very parts on which the integrity of the reactor depends—are, for all practical purposes, inaccessible from the start. The large size of many components, and the necessity for fabrication on site also add to the necessity for ensuring the highest standards right from the start.

The paper, then, deals with the subject from materials to general inspection, site inspection, pressure testing and periodic inspection, and it is a matter for regret that space does not permit of the extensive quotation that this work undoubtedly deserves; it is only possible to mention a few points. In the case of materials, the paper mentions the progress made in the last five years in narrowing the gap between the impact properties of forgings and plate materials. Of interest also is the proposal that high-tensile steels proposed for pressure vessels should first be tried out on heat-exchanger shells. An interesting point of the section on general inspection is the necessity, where internal insulation is used to keep down shell temperatures, of ensuring that the insulation is not only efficient thermally, but that its mechanical soundness should be beyond question.

Under site inspection, there is something to be said regarding plate widths. Although, as the authors admit, the fabrication of a large vessel to close tolerances is a work of art, there is a good deal to be said for trial assembly of plate courses before leaving the factory; it is possible that errors may be cumulative, and wholesale building-up of edges is not permissible. The effect of small unavoidable fabrication irregularities is given emphasis in a later section: in comparing strain gauge results on six nominally identical pressure vessels at Calder and Chapelcross, variations from average to maximum recorded strain concentration factors were about 50%.

Other interesting features included the adoption of a Lloyd's Register suggestion that groups of test pieces representative of shell plates and butt welds should be placed within the reactor and a proportion withdrawn at intervals over a 20-year period.

As has been previously stated, this is not the sort of paper which can be adequately summarized in a short space. The general theme, however, can best be epitomized by a quotation: " However detailed a specification, the quality of a component made thereto mainly depends on the manufacturer. While an inspecting authority is expected to make sure that parts comply with the relevant specifications, its responsibility lies beyond these terms. It should be able to make a reasonable assessment of the abilities of manufacturers and to take action if the findings indicate deficiencies."

THE INSTITUTION OF CIVIL ENGINEERS

Some contributions from Nuclear Power to Engineering Practice. By Ian Davidson, M.Eng., M.I.C.E. (Deputy Chief Engineer, D. and E. Group, U.K. AEA.)

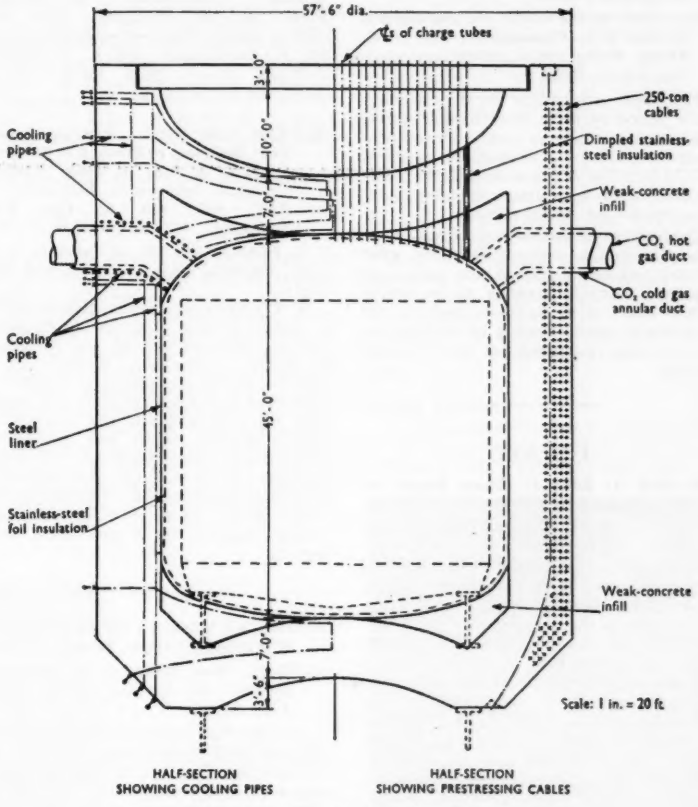
Nuclear engineering has made worthwhile contributions to general engineering not only in the extrapolation of existing techniques, but in the introduction of a more scientific approach to a good many problems. It has also made it worth while to develop well-known ideas hitherto unattractive because of limited demand.

One example of increased interest in an existing problem was the large amount of work devoted to the problem of brittle fracture, which the paper briefly examines. There is evidence that good notch ductility is more easily obtained in steels produced in electric furnaces rather than by the open-hearth process. There is also intensive research proceeding in an endeavour to co-relate the results of the Robertson isothermal wide-plate test (considered to be the best for determining crack-arrest temperatures, but expensive and time-consuming) with the results obtained by the routine Charpy V-notch impact tests. This work on brittle fracture, although it will be of considerable importance in the field of pure knowledge, and in many other applications, was largely initiated by the nuclear programme. Other examples were the development of ultrasonic testing as a production routine, and the increased interest in the use of accelerators for high-power X-ray work.

Nuclear work had also been responsible for advances in pressure vessel design, some of these advances being briefly reviewed. Amongst the features mentioned was the use of insulation to control the shell temperature. Particular emphasis was laid on the necessity for mechanical integrity of the insulation; the use of multi-layer deformed stainless steel foil would appear to have interesting possibilities.

Concrete biological shielding had also led to a much clearer understanding of the behaviour of a complicated structure under mechanical stresses and thermal gradients.

An important object of the paper was to focus attention on the use of prestressed concrete for pressure vessel construction. Reference was made to the use of this technique at Marcoule, proving the practicability of the idea, and the requirements and possible solutions were briefly examined.



Vertical cross-section of concrete vessel.

One outstanding feature is, of course, that there is no advantage to be gained by making the vessel spherical, so that better space utilization is obtained, even at the expense of adding fresh problems. There is, for example, considerable difficulty in allowing large gas ducts to penetrate the barrel portion directly, on account of interference with hoop reinforcement. When the ends of the vessel are designed as concave-outwards domes, however, there is a zone between the end of the barrel and the springing of the dome which requires less hoop reinforcement and will allow the passage of the gas ducts.

Using cables and anchorages commercially available it should be possible to develop net hoop compression of more than 1,000 tons per foot run of a cylindrical barrel—equivalent to 11 in. steel, or a sphere 7½ in. thick. Concrete, therefore, offered a significant step forward in performance.

In addition to the saving in cost between a concrete vessel and a steel vessel with a concrete shield—which could only be evaluated by estimation of comparable

designs—there should be a gain in safety. Failure due to gross overpressure in a concrete vessel occurred progressively, commencing with cracking of the concrete followed by local failure of the steel lining; a considerably less catastrophic failure than that of a steel vessel.

The design illustrated was from a study which had been made to fit a concrete vessel into a scheme primarily optimised for a steel vessel (advanced gas cooled reactor). There were, therefore, several handicaps, not the least of which was inadequate headroom, causing the domes to be flatter than was desirable. The vessel in question had an internal diameter of 42 ft, and height of 45 ft, with a barrel thickness of 7 ft 9 in. It would weigh nearly 24,000 tons, and would operate at 300 p.s.i., with inlet and outlet temperatures of 300°C and 500°C, respectively. Cooling would require a 660 h.p. pump to circulate 28 x 10^6 gal/day of water.

THE INSTITUTE OF MARINE ENGINEERS (Joint Nuclear Marine Propulsion Panel)

Observations on the design and construction of the N.S. "Savannah." By J. A. Dodd, B.Eng., A.M.I.Mech.E., and S. Macdonald, B.Sc.

This paper summarizes the reports covering a period of some three months during which eight weeks were spent with the New York Shipbuilding Corporation, regularly visiting both the ship and the reactor mock-up, and four weeks visiting contractors, AEC laboratories, and reactor sites.

Dealing at some length with shipyard practice, ship design, engineering notes, crew training and health physics, the paper contains too much information to be readily summarized. It is, however, probably the most useful general account of the ship that has yet been published, at least, in this country.

U.S. AEC

TID 8518 (1) Book 1. Status Report on Fast Reactors as of 1959. (U.S. Government Printing Office, Washington 25, D.C. $1.00.)

A 99-page volume of text, diagrams and curves evaluating the technical and economic status of the fast breeder reactor. About one-quarter of the report is devoted to the objectives of the fast-reactor programme and a detailed account of general research and development completed and under way. This section includes physics; fuel and material properties; heat transfer; fluid-flow experiments; coolant chemistry; reactor safety; components and systems.

Brief descriptions of projects include EBR-I and II; Clementine; Enrico Fermi; and the British and Russian fast-reactor effort. There are drawings of a number of projects, construction schedules of the Enrico Fermi, EBR-II and the plutonium-fuelled project PFFBR. The report includes a bibliography of nearly 450 references.

TID 8519. Civilian Power Reactor Program—Plans for Development as of February, 1960. (U.S. Government Printing Office, Washington 25, D.C. $0.25.)

This report summarizes the objectives of the civilian power reactor programme with respect to the light water, heavy water, organic, liquid metal and enriched gas cooled types as well as the aqueous homogeneous reactor. A brief review of the nuclear technology programme and a cost analysis are included.

NAA-SR-5688. Proceedings of the Organic Cooled Reactor Forum

A collection of the papers read at a meeting sponsored by the U.S. AEC in Los Angeles, October 6/7. Contents include:—"Status of Organic Coolant Technology" (R. H. J. Gercke); "Status of Heat Transfer Development for Organic Reactors" and "Status of Process Development for Organic Reactors" (both by W. R. Martini); "Status of OMR Fuel Element Development at Atomics International" (H. Pearlman); "Current Status of OMR Experimental Physics" (H. N. Royden); "OMRE Operating Experience" (R. O. Williams, Jr.); "Canada's Research and Development Programme for an Organic Liquid Cooled Nuclear Reactor" (W. M. Campbell); "Experimental Organic Cooled Reactor" (M. R. Dusback); "The Piqua Nuclear Power Facility" (E. F. Weisner); "Intermediate Size Prototype Plant" (J. E. Brunings); "300 MWe OMCR Power Plants—Present and Future" (R. K. Winkleblack and R. J. Gimera); "OCDR Power Plant Study" (J. R. Dickinson and R. F. Scarth).

TID-8200 (2nd Rev.). Nuclear Reactors Built, Building, or Planned in the United States as of June 30, 1960. (Office of Technical Information Extension, U.S. AEC, P.O. Box 52, Oak Ridge, Tennessee. No charge.)

A complete list of all reactors in the U.S., classified under the following headings:—

A. Civilian power and propulsion reactors. B. Other civilian reactors (experimental, test, research and training, and specialized). C. Military propulsion, power and test reactors (naval propulsion, prototypes and experiments, research and test). D. Production reactors (materials and testing). E. Export reactors (power, and research and training and critical facilities). F. Critical assembly facilities, and identification of experiments and studies. This useful publication brings up to date the information usually listed in the Commission's annual reports.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (Heat Transfer Division)

60-HT-22. Pool Boiling in an Accelerating System. By Herman Merte, Jr., and J. A. Clark.

A study of the influence of system acceleration on pool boiling heat transfer. The accelerating force (1-21*g*) was applied by means of a centrifuge so that the resulting force field was normal to the heating surface, thus increasing the buoyant forces acting on the bubbles. Distilled water was used at atmospheric pressure; heat fluxes were varied from 5,000-100,000 B.t.u./h.ft^2. A preliminary analysis is given for boiling under both high acceleration and natural convection.

Cmnd. 1173. Report of the Advisory Committee on the Examination of Steam Boilers in Industry. (Ministry of Labour White Paper, H.M.S.O., 1s. 3d.)

It has been suggested that the present requirement of inspection at intervals not longer than 14 months could, with advantage be relaxed. The Report, in addition to a number of appendices, gives a summary of evidence and the Committee's recommendations. These, as well as making certain suggestions concerning the training of operators and the treatment of feedwater, give the opinion (one member disagreeing) that new boilers should be examined between 8-14 months after commissioning, and the periodical inspection, for boilers above 50,000 lb/h, should take place every 26 months for 21 years of life, after which it should revert to 14 months. Similar recommendations were made for banks of boilers totalling 100,000 lb/h with minimum units of 25,000 lb/h, and for waste-heat boilers on large process plants.

For heat exchangers in nuclear power stations, there should be full consultation between the Ministry of Labour, the Ministry of Power, and other interested bodies such as the U.K.AEA about the inspection period before a licence was issued; for heat exchangers which could be isolated, the period should be 14 months for the first examination, and 26 months thereafter.

List of Publications Available to the Public. Cumulation No. 4. January-December, 1959. Library, AERE, Harwell. (H.M.S.O. 23s.)

A comprehensive (144 pp.) list of reports and memoranda, translations, books and periodical articles for 1959, classified in subject groups and complete with author and serial number indexes.

MEETINGS

November 29.—The Society of Instrument Technology. (Data Processing Section, London, at Manson House, 26 Portland Place, W.1, 6.30 p.m.) Symposium on Nuclear Temperature Scanning. **Temperature scanning equipment for a large nuclear reactor.** C. Hall, B.Sc. **Temperature scanning equipment for use in a nuclear power station.** A. G. Blay, M.Sc., A.M.I.E.E., P. G. Davey, M.A., and F. C. Flint.

November 30-December 2.—The Iron and Steel Institute in conjunction with the B.N.E.C. (At Church House, London, S.W.1, 9.30 a.m.) **Symposium on Steels for Reactor Pressure Circuits.**

December 1.—The Institution of Electrical Engineers. (Southern Centre, at South Dorset Technical College, Weymouth. 6.30 p.m.) **Instrumentation of Nuclear Reactors.** D. Harrison.

December 6.—The Institution of Electrical Engineers. (North-Western Utilization Group, at the Engineers' Club, Albert Square, Manchester. 6.15 p.m.) **Electrical Characteristics of the Argon Arc Welding Process.** J. C. Needham, B.Sc.(Eng.), and L. H. Orton, B.Sc., Ph.D.

December 7.—The British Nuclear Energy Conference. (The Institution of Mechanical Engineers, at 1 Birdcage Walk, London, S.W.1. 2.30 p.m.) **Symposium on the Dounreay Fast Reactor.**

December 8.—Society of Chemical Industry. (Joint meeting with Bristol Section at University of Bristol Chemical Dept., Woodland Road, Bristol. 6 p.m.) **Some Design Aspects of Gas Cooled Nuclear Power Stations.** R. E. Bucknell.

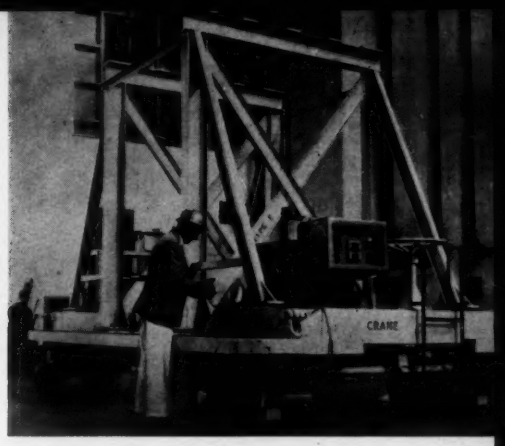
December 13.—Society of Chemical Industry. (At 14 Belgrave Square, London, S.W.1, 6 p.m.) **Mechanical and General Maintenance Problems of the Chemical Industry.** R. H. Keach. **Electrical Maintenance Problems of the Chemical Industry.** D. Marshall.

December 14.—The Institution of Electrical Engineers. (South-Western Sub-Centre, at Washington-Singer Laboratories, Exeter University, Prince of Wales Road, Exeter. 3 p.m.) **The Application of Irradiation in Industry.** M. C. Crowley-Milling.

December 15.—The Institution of Mechanical Engineers. (At 1 Birdcage Walk, Westminster, London, S.W.1, 6 p.m.) Nuclear Energy Group Discussion, **The Impact of a Three-Fuel Economy.**

Processes and Equipment

For further information on any item please enter the relevant number on the Reader Service Card enclosed with this issue and forward the card to the address given.



The Cranes' transporter for Berkeley.

Charge-Discharge Machine Transporter for Berkeley

Fuel and control rod handling at Berkeley power station utilizes a number of separate machines (*Nuclear Engineering*, April, 1960) which are not themselves mobile. The Cranes, Ltd., transporters, two of which have been ordered for the station, present some highly unorthodox features.

For example, propulsion is not, as might be expected, by geared motors to the wheels. Instead, the rear wheels slide, as a unit complete with axles, under the control of a hydraulic cylinder, the total travel being some 16 in. All four pairs of wheels have spring-applied brakes with hydraulic release, so that the machine moves forward by releasing the front brakes, applying the rear brakes and applying thrust to the back axles; the process being reversed to retract the axles for the next move. Hydraulic steering is provided for the rear wheels; manual steering for the front.

To appreciate the reasons underlying the choice of this type of propulsion, it is necessary to consider the overall station design. It was not possible to cover both charge floor and maintenance area with a single crane, and the transporter is required to act as a connecting link between the two separate cranes. The weight of the charge/discharge machine dictated the use of eight wheels; the necessity for manœuvring in a confined space required double-ended steering. To apply orthodox propulsion would have necessitated either individual motors to each wheel or a mechanical transmission of considerable complexity; the "kangaroo" propulsion presented the best solution, bearing in mind that the maximum travel is about 40 ft.

The hydraulic system operates from a pump which is motor-driven from a 24V Nife battery; one of the requirements was that no external connections should be required during operation.

(Cranes (Dereham), Ltd., South Green Works, Dereham, Norfolk.)

1384

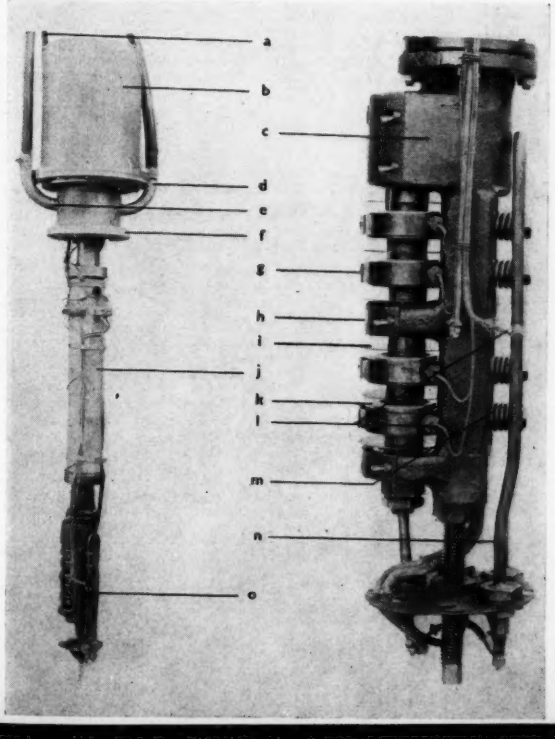
Irradiation Testing of Lubricants

The testing of lubricating greases under reactor working conditions has taken a notable step forward with the design of a test rig known as SETRA (Submerged Elevated Temperature irRadiation Apparatus) in which a bearing assembly can be subjected to mechanical loading at a high temperature in an atmosphere of CO_2 under a high gamma flux. Since pile irradiation severely limits the size of test rigs, SETRA was designed to operate in the spent fuel element irradiation pond at Harwell, where a gamma flux of up to 3 Mrad/h can be obtained on a test assembly of reasonable size, while the motor can be located far enough from the intense field to prevent damage to the windings.

The general arrangement of the unit, removed from its irradiation can, is shown in the illustrations, that on the right giving an enlarged view of the actual test assembly (o). This consists of four test bearings which can be individually loaded by screw-down springs. The shaft, which is supported in three slave bearings, is driven at 900 r.p.m., through the gearbox (c). CO_2 is continuously circulated, and the temperature of the test bearings can be adjusted, by heaters, to 250°C, ambient and bearing temperatures being indicated by thermocouples. Failure of a grease under irradiation is shown by a rise in bearing temperature. To date, various products have been tested to doses exceeding 1,000 Mrad.

(Mobil Oil Co., Ltd., Caxton House, Tothill Street, Westminster, London, S.W.1.)

1385

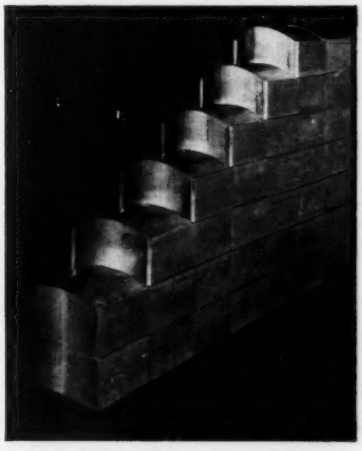


General view of SETRA rig with housing removed and an enlarged view of lower portion.

a, CO_2 supply tube; b, motor and housing; c, gearbox casing; d, e, return conduits; f, adaptor; g, h, bearing housings; i, seepage throwers; j, extension tube; k, seals; l, thermocouples; m, screw-down springs; n, heaters; o, test assembly.

Lead Bricks

An interesting variation of the more usual V-joints for the prevention of radiation streaming is shown by the Belgian-made lead bricks illustrated, which have smoothly-curved surfaces with chamfered edges, to perform the same function.



Lead bricks with curved mating surfaces.

(Compagnie des Metaux d'Overpelt-Lommel et de Corphalie, S.A., 54 Rue des Fabriques, Brussels, 1.)

1386

Cutaway drawing of the Atomics International reactor safety device.

Reactor "Fuse"

Reactor safety devices corresponding to fuses in an electrical circuit have previously been described in principle (*Nuclear Engineering* December 1958, p. 521). They have now been developed as operational units, and are being used in the critical experiment for the Maritime Gas-cooled Reactor at San Diego, California.

The general construction can be seen from the illustration. Partly inserted in the reactor core, the cylinder contains boron trifluoride gas under high pressure, in a compartment at one end. In the event of a power surge, a thermal trigger device releases the gas, allowing it to expand and fill the portion of the cylinder which lies within the core, thus adding additional neutron-absorbing material, in the same way as would a control rod rapidly inserted. Nine such fuses have been manufactured for the reactor, which is being operated by General Atomic division of General Dynamics Corporation for the U.S. AEC.

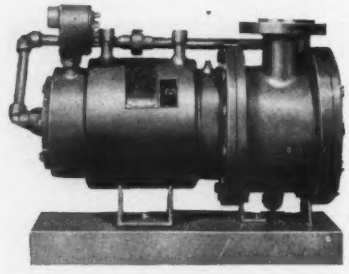
(Atomics International, P.O. Box 309, Canoga Park, California.)

1387

Canned Pumps

Chempumps, a range of canned-rotor pumps manufactured by the Chempump Corporation, of Philadelphia, are being made available in Britain; a portion of the range being manufactured here, and other models imported.

Chempumps are manufactured in both single-stage and two-stage types, in a variety



A typical Chempump unit.

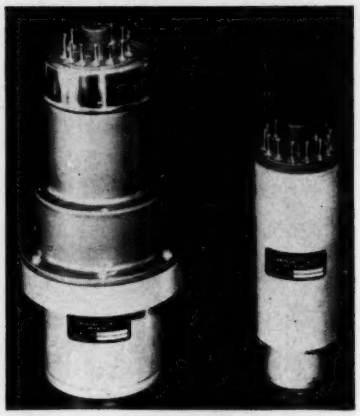
of materials to suit the working pressure and the corrosive characteristics of the particular application. Bearing lubrication is by a tapping from the high-pressure side; in cases of slurries or particularly difficult materials, a clean feed of suitable fluid is provided at a few p.s.i. above pump pressure, and subsequently mixes with the main flow. Single-stage pumps are made in sizes of ¾ h.p. to 15 h.p., with capacities up to 450 gal/min, for heads up to 170 ft, depending on capacity; pumps can be designed for line pressures up to 5,000 p.s.i. Double-stage pumps (5-15 h.p.) have capacities up to 50 gal/min, operating head (depending on capacity) being up to 400 ft, and line pressures up to 3,500 p.s.i. Both types are made with Class A motor insulation for operation up to 180°F, or Class H insulation for up to 400°F; special high-temperature designs are available for 850°F double-stage, or 1,000°F single-stage.

(L. A. Mitchell, Ltd., Harvester House, 37 Peter Street, Manchester, 2.)

1388

Scintillation Detectors

Main features of a new range of crystal-photomultiplier units are improved gamma resolution, improvements in optical arrangements and light-tightness and a wide range of crystals. In the standard NaI (Tl) series, crystals range from specially thin (0.015 in.) to large units (9 in. diameter) with three or four photomultipliers. For very low-level activities, crystals are supplied with a K content as low as 1-3 ppm. For α-particle or proton detection CsI (Tl) crystals can be supplied, or anthracene, for β-particles. Typical resolution figures for the 0.661 MeV gamma photopeak of Cs^{137} are 7-9.5% for crystals up to 3 × 3 in., and 8-10% for larger crystals; well-type crystals give about 2% better resolution.



Typical Nuclear Enterprises' crystal-photomultiplier units of (left) demountable, and (right) integral types.

All crystals up to 2 in. diameter are integrally mounted (except the specially thin type). Between 2 in. and 5 in. diameter, demountable types are used, with the crystal independently mounted and viewed through an optical window. Photomultipliers are of EMI manufacture, and magnetic shields are provided.

(Nuclear Enterprises (G.B.), Ltd., Bankhead Medway, Sighthill, Edinburgh, 11.)

1389

BRIEFLY . . .

Westinghouse Electric International Company, 40 Wall Street, New York 5, announce a new ionization chamber for continuous operation up to 500°F. Designed to operate in the range 10^4—10^{10} n/cm².sec, it has a neutron sensitivity of 4.4×10^{-14} A/r.h and a gamma sensitivity of 5×10^{-11} A/r.h. **B190**

A new Philips low-temperature refrigerator is announced by **Research and Control Instruments, Ltd.,** Instrument House, 207 King's Cross Road, London, W.C.1. Operating in the region of −200°C and up to 450 p.s.i., the machine can be supplied with an auxiliary unit for making liquid air directly from the atmosphere. A fractionating column for liquid nitrogen production is under development. **B191**

New welding electrodes introduced by **Lincoln Electric Co., Ltd.,** Welwyn Garden City, Herts, are known as NuFive and NuSeven. NuFive is a smooth-flowing mild steel electrode of the cellulose type for welding mild steel in all positions using a.c. or d.c., and is particularly suitable for pipe welding. Its B.S. 1719 classification is E.111. NuSeven, of the iron powder-rutile type, for all-position welding of mild steel, is stated to have a faster deposition rate than conventional titania electrodes; its classification is E.917. Both are approved by Lloyd's Register and the Ministry of Transport. **B192**

Counting Instruments, Ltd., 5 Elstree Way, Boreham Wood, Herts, whose digital display unit was recently illustrated in these columns (*Nuclear Engineering*, August, 1960, p. 376) have introduced a new unit, the Series 80,000 which will display any or all of a number of digits or words, backlighted in colour. **B193**

"Metox" resistors, made by **Welwyn Electric, Ltd.,** Bedlington, Northumberland, are now being made in a special high voltage pattern, originally developed for AERE. The use of a film of metal oxide gives improved reliability and stability, compared with carbon or wirewound types. Resistance values of 2—500 megohms are available, the maximum operating voltage being 10 kV d.c. continuously or pulse of 50 kV. **B194**

The "Mopump" range, manufactured by **Rhodes, Brydon and Youatt, Ltd.,** Reddish Engineering Works, Stockport, Cheshire, has been extended by new models known as the "SC" type, intended for high pressures and comparatively small flows, the steep head/quantity curve making them particularly suitable for boiler-feed work. Of unit construction, the SC Mopump uses only a single seal, at the low-pressure end, with an extended surface seat allowing operation up to 200° F. **B195**

A new transistorized d.c.-d.c. converter, introduced by **Aveley Electric Ltd.,** Ayron Road, Aveley Industrial Estate, South Ockendon, Essex, has been designed to replace rotary converters and vibrator packs. Toroidal transformers and bifilar windings give accurate balance and fast switching. The units are available with outputs ranging from 5-120 W and input voltages from 6-24. The standard output voltage is 300, with taps at 200 and 250 V. **B196**

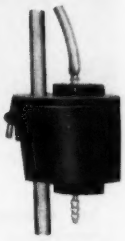
Berry Wiggins and Co., Ltd., Field House, Breams Buildings, London, E.C.4, announce that they have, in co-operation with Borax Consolidated, Ltd., produced a range of boronated bitumen compounds, including Kingsnorth 2028, which contains a bitumen-soluble compound free from sedimentation troubles. **B197**

Metalife Duplex Metal Coating, a product of **Metalife Liquid Metals Limited,** Harrogate, Yorkshire, is a two-pack system (base and solidifier) which, when combined, gives a double-thickness coating in one brushing. Two brushed coats give a deposit of 2.1 oz/ft² of anodic metal; equivalent to good-quality galvanizing. It is also stated that the material can be applied to damp surfaces and does not drip or run on application. It will also withstand temperatures from −60°F to −400°F. **B198**

Hancock and Co. (Engineers), Ltd., of Progress Way, Croydon, Surrey, announce that their Hancoline oxygen profiling machine can now be fitted with automatic height control for the burners. Raising and lowering of the burners is carried out by a small motor under electronic control. Height sensing is by variation in capacitance between the plate and a probe ring attached to the burner. **B199**

Solenoid-operated Glass Valve

The advantages of solenoid operation without the introduction of metallic surfaces into a glass flow system can be achieved by the Grundy solenoid valve, in which the complete valve passes through the solenoid, and on/off control is provided by an iron-cored glass plunger. This has a ground glass plug at the lower end, which mates with a ground seating in the glass body, which has an overall length of 110 mm, including extensions to accommodate 5 mm diameter tubing. The valve is suitable for a maximum flow of 525 cm³/min, at a head of 60 cm of water, and is operated from 200/250 V supplies from a 12V step-down transformer, housed in a control unit suitable for simultaneous control of up to three valves.



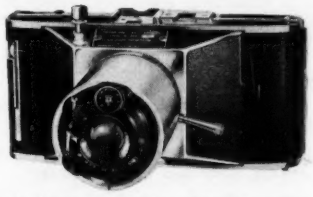
Grundy solenoid-operated glass valve, mounted on laboratory stand.

(Griffin and George, Ltd., Ealing Road, Alperton, Middlesex.)

1390

Oscilloscope Recording Camera

A new Thompson camera for recording oscilloscope traces, known as the Series 410, supersedes the previous Series 400 model, the main changes being in the optical system. The f/3.5 lens is now fitted with a diaphragm for stopping down to f/32, is fitted with a helical focusing mount, and has a between-lens shutter of the Compur type, with speeds ranging from 1-1/125 sec. Like its predecessor, the camera uses Polaroid film, which is processed within the camera to give a positive record within 60 sec, no dark room being required.



The Thompson Series 410 oscilloscope camera.

(J. Langham Thompson, 176 High Road, Bushey Heath, Herts.)

1391

Glass Phosphor

Preliminary details of an activated glass phosphor suitable for scintillation counting, developed by B.S.I.R.A., were given some months ago (*Nuclear Engineering*, April, 1960, p. 189) and it is now possible to give further information. The glass, known as GS1, is a lithium alkaline earth silicate glass, activated by cerium, and has a density of 2.7 and a refractive index of 1.57. It is chemically inert, and can be used in contact with strong nitric acid solutions; can be moulded and optically worked, but is not suitable for lamp-working. Response to γ radiation from Cs^{137} is about 15% of that obtained with NaI crystal; the decay time is between 10^{-7} and 5×10^{-8} sec.

At present, GS1 can be supplied in discs up to 1½ in. diameter, and ⅛ in. thick, as-cast, or ground and polished, and reflecting media such as evaporated aluminium or titanium pigment can be applied to the surface. Work is in progress to develop larger sizes, simple moulded shapes, and filaments.

(Nash and Thompson, Ltd., Hook Rise, Tolworth, Surrey.)

1392

Automatic Feedwater Analysis

Users of highly-rated boilers or heat exchangers need no reminding of the importance of low silica content in feedwater. What is claimed to be the first commercially-available automatic silica analyser has just been marketed. It operates on the principle of photo-electric observation of the colour of a water sample which has been treated with reagents (molybdate solution plus a reducing agent) which give a blue colouration proportional to the amount of silica present.

Electronic Instruments' silica analyser.

Measurement of the sample, mixing and comparison, all take place within the instrument, on an automatic time cycle (12 min), and the differential output of the photocells observing the blued sample and the "reference" feed a transistor amplifier which gives an output of 1 mA into a resistance of 1,500 ohms for full-scale deflection. Three ranges are available, for 0.2; 2.5; 30 ppm of silica in the water, the accuracy being ±5% full scale.

(Electronic Instruments Ltd., Richmond, Surrey.)

1393

Temperature Indicator/ Controller

Latest addition to the Bikini range of instruments is an inexpensive electronic temperature indicator/controller which is transistorized to reduce maintenance. With a 6 in. diameter (13 in. scale) flush mounting case the instrument is suitable for use on either 12 V d.c., or mains supply, and has an indicating pointer driven from a servo-system. The measuring bulb is a platinum resistance housed in a stainless steel sheath; distances of up to 300 ft between bulb and intrument can be accommodated without loss of accuracy (0.5% full scale).

The new Bikini temperature indicator / controller.

The control relay has 10 amp changeover contacts, and a repeatability of 0.25°C is said to be obtainable on most ranges, of which there are 73, for temperatures between −200°C and 850°C (−330°F to 1,550°F).

(Fielden Electronics, Ltd., Wythenshawe, Manchester.)

1394

CATALOGUES

The principles behind electron beam heating are described in an article in Vol. VII No. 55 of the **Wild Barfield** *Heat Treatment Journal*.

Leaflets received from **Bristol Electronics,** Filton House, Bristol, describe their analogue digital converter, automatic data processing equipment and multi-channel digital recorder.

Stress Relieving Services, Ltd., 32 Sydenham Park, Sydenham, London, S.E.26, have issued a booklet describing their equipment and facilities for preheating and stress-relieving pipes on site. A stress-relieving service is offered at present; the equipment will be marketed at a later date.

Hints on machining Zirconite machinable refractories are given in a leaflet received from **W. and C. Spicer, Ltd.,** The Grange, Kingham, Oxon.

Pneumatic temperature-measuring systems for indicating and recording over distances up to 500 ft are described in a leaflet 331/1 received from the **Cambridge Instrument Co., Ltd.,** 13 Grosvenor Place, London, S.W.1.

From **Marshall Cambridge Electronics, Ltd.,** The Airport, Cambridge, leaflets on twin channel analysers and pulse height analysers.

Vacuum valves as described in *Nuclear Engineering*, March, 1960, page 141 and right-angle vacuum valves are described in booklets received from **Vacuum Research (Cambridge), Ltd.,** Quayside, Bridge Street, Cambridge.

We welcome the first issue of the *Engelhard Industries Technical Bulletin* **(Baker Platinum Division,** 52 High Holborn, London, W.C.1.), which includes an article on high temperature thermocouples.

An automatic X-ray fluorescent spectrometer is described in Vol. VI No. 2 of the *Hilger Journal* received from Hilger and Watts, Ltd., 98 St. Pancras Way, Camden Road, London, N.W.1.

A brochure which describes six typical uses of the EMIDEC 1100 all-transistor data processing system, has recently been issued by **E.M.I. Electronics, Ltd.,** Hayes, Middlesex.

Among leaflets received from **Henry Wiggin and Co., Ltd.,** Thames House, Millbank, S.W.1, are two on the applications of Nimocast heat resisting alloys and developments in Nimonic heat-resisting sheet alloys.

An article in Vol. IV No. 4 of the *Platinum Metals Review* **(Johnson Matthey and Co., Ltd.,** Hatton Garden, London, E.C.1), refers to improved corrosion resistance in a homogeneous reactor by addition of small amounts of platinum to type 304 stainless steel.

A new gamma ray source container is described in No. 18 of the *SS News* published by **Solus-Schall, Ltd.,** County Building, Honeypot Lane, Stanmore, Middx.

A booklet produced by the **B.S.A. Group of Companies,** 54 St. James's Street, London, S.W.1, details products for the nuclear engineering industry which the various companies in the group are producing.

Negretti and Zambra, Ltd., 122 Regent Street, London, W.1, have issued a new catalogue B.21 describing air operated receiving instruments.

The **Scientific Instrument Manufacturers' Association,** 20 Queen Anne St., .W1, have issued a booklet entitled "Careers in the Scientific Instrument Industry."

A. M. Lock and Co., Ltd., 70 Union Street, Oldham, Lancs, have issued three new leaflets on their humidity indicator, effluent control equipment, and a laboratory conductivity bridge.

Rockweld, Ltd., Commerce Way, Croydon, Surrey, have issued a booklet on their circomatic seam-welding machine.

Heat-resistant coatings by metal spraying are described in a leaflet received from **Metallisation, Ltd.,** Barclays Bank Chambers, Dudley, Worcs.

From the **English Electric Valve Co., Ltd.,** Chelmsford, Essex, comes a booklet describing in detail their type E 702 storage tubes.

Desoutter Bros., Ltd., The Hyde, Hendon, London, N.W.9, have issued a new catalogue on portable pneumatic tools.

Personal

Appointments

Dr. A. Trevor Churchman as deputy director of the CEGB's Berkeley Nuclear Laboratories.

Mr. W. T. Flower as deputy managing director of Bailey Meters and Controls.

Sir William McFadzean, as chairman of the newly formed Export Council for Europe, an organization sponsored by industrial, trade union and governmental departments and organizations.

Professor V. Weisskopf as a research member of a directorate to assist the director-general of CERN.

Mr. G. R. Buckley and **Mr. C. G. Mackie** as joint deputy managing directors of Stanton Ironworks; also **Mr. E. M. Summers, Mr. L. Rawlins** and **Mr. C. H. Wilson** to the board.

Sir Hamish D. MacLaren and **Sir Vincent Tewson,** as part-time members of the London Electricity Board.

Mr. Derek R. R. Dick, of W. S. Atkins and Partners, has been seconded to Richard Thomas and Baldwins as construction manager at the Spencer works.

Dr. J. M. Holm as chairman of the Nobel division of Imperial Chemical Industries.

Sir Harold Gillett to the board of Barrow Haematite Steel Company.

Sir Roy Dobson as director and chairman of Blackburn Aircraft.

Mr. G. W. Ashton and **Mr. J. Elliot** to the board of Firth-Vickers Stainless Steels.

Air Commodore J. Warburton to the board of Frederick Braby and Co.

Mr. H. Darnell as director and general works manager of Steel Peech and Tozer.

Mr. N. D. MacDonald as general works manager of Workington Iron and Steel Company.

Mr. R. D. Stafford as chief engineer, industrial division of Cawkell Research and Electronics; also: **Mr. R. Reeves,** as chief engineer, special products division, and **Mr. D. Parker,** as senior engineer, special services.

Mr. F. Dransfield as power plant design engineer of the Central Electricity Generating Board, also **Mr. S. F. Newey** as project engineer of the Midlands Project Group.

Mr. A. N. Provost as Managing Director of Texas Instruments, Ltd.

Mr. N. E. F. Hitchcock as laboratory manager of the Castrol Group's main research establishment at Hayes, Middlesex.

Professor W. Libby.

Professor D. Glaser.

Mr. W. S. Stringham.

Mr. S. Fawcett.

Dr. Earl Long.

Dr. J. Ernest Wilkins.

Mr. N. A. Slater as commercial manager of Pollard Ball and Roller Bearing Co.

Mr. P. B. H. Brown as chairman of Worthington-Simpson.

Mr. J. C. Abberley as director in charge of Firth Cleveland Tools' Tipton works, and **Mr. A. H. McIlreath,** director in charge of its factories at Wolverhampton.

Mr. R. V. Moore as deputy managing director, projects; **Dr. H. Kronberger,** deputy managing director, development; and **Mr. P. T. Fletcher,** deputy managing director, general management, of the U.K. AEA's development and engineering group. **Mr. S. Fawcett** becomes director of reactor design and **Dr. H. K. Hardy** and **Mr. F. W. Fenning** have been appointed director of fuel element development and director of reactor technology, respectively, at Risley.

Mr. W. E. J. Farvis to the newly established chair of electrical engineering at Edinburgh University.

Mr. Karl M. Jones and **Mr. Malcolm S. Vaughan** to the board of Llanelly Steel Company (1907).

Mr. F. R. Mason as managing director of Associated Electrical Industries (Export), and **Mr. H. West,** managing director of A.E.I. (Manchester), as director of the export company.

Mr. R. G. Roberts as sales manager of W. H. Sanders (Electronics).

Mr. A. S. Duncan to the board of Young Accumulator Company, **Mr. A. E. Gregg** to the board of Crompton Parkinson (Chelmsford), **Mr. J. C. Mansfield** and **Mr. D. Ebben** to the board of F. and A. Parkinson. **Mr. K. Younger** to the boards of Crompton Parkinson (Chelmsford), the British Electric Transformer Co., and Cooke and Ferguson. **Mr. C. J. W. Scott** to the boards of F. and A. Parkinson and Crompton Parkinson (Doncaster).

Overseas

Dr. Frank E. Harris is to head a new computing department at the Bio-Rad Laboratories, Richmond, California.

Mr. William S. Stringham to supervise activities at The Martin Company, Quehanna, Pennsylvania.

Mr. Philip Des Marais as applications engineer at Brooks Instrument Company, Hatfield, Pennsylvania.

Dr. J. Ernest Wilkins, Jr., as assistant chairman of the theoretical physics department of the John Jay Hopkins Laboratory for Pure and Applied Science, San Diego. Also **Dr. Earl A. Long** as assistant director. The laboratory is operated by the General Atomic Division of General Dynamics.

Mr. William R. Claypoole as marketing representative for Spencer Chemical Company's Nuclear Fuels Department, Kansas City, Missouri.

Awards

Professor Donald Glaser, of California University, has been awarded the Nobel Prize for Physics for inventing the bubble chamber. **Professor Willard Libby,** until last year a member of the U.S. AEC, has received the Nobel Prize for Chemistry for his work on the development of the carbon-14 tracer method of determining the age of archæological and geological specimens.

Sir Christopher Hinton, chairman of the Central Electricity Generating Board, and **Sir William Holford,** part-time member of the Board, have been awarded R.S.A. Silver Medals for their papers on "Power Production and Transmission in the Countryside: Preserving Amenities" read to the Royal Society of Arts in November, 1959.

Resignations

Mr. Dudley Saward as managing director of Texas Instruments.

Mr. Claud Laurence from the board of Laurence Scott and Electromotors.

Dr. A. R. Morcom from the board of Daniel Adamson and Co.

Retirements

Mr. E. B. Small has retired from executive work with A.E.I. (Export).

Mr. H. Stewart Craig from the board of the Llanelly Steel Company (1907).

Dr. James Craik as chairman of the Nobel Division of I.C.I.

Sir Samuel R. Beagle as chairman of Worthington-Simpson.

Mr. J. Abberley from the board of Firth Cleveland Tools.

Mr. Cyril F. Morgan as London office sales manager of Henry Hargreaves and Sons, Ltd.

Obituaries

Nuclear Engineering regrets to report the death of: **Mr. John Weston Woodfield** and **Mr. Maurice Vernon Ratcliffe,** nuclear engineers employed by Kennedy and Donkin. They were killed in an aeroplane crash in Brazil.

Dr. George McLennan, senior scientific officer responsible for development of chemical plant at Dounreay, Chemical Division, who was killed in a car crash.

"NUCLEAR ENGINEERING"

1960

BUYERS' GUIDE

to

British manufacturers

and

suppliers

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ADDRESS SECTION

A.C.M. ELECTRONICS, LTD., 61 Osborne Road, Acton, London, W.3. Tel.: Acorn 6931. T.A.: Rivetier Ealux London. (319, 353, 360, 384, 385, 400, 451, 452)

A.E.I.—BIRLEC, LTD., 33 Grosvenor Place, London, S.W.1. Tel.: Belgravia 7011. T.A.: Assoelect London. (303, 322, 352)

A.E.I.—JOHN THOMPSON NUCLEAR ENERGY CO., LTD., 33 Grosvenor Place, London, S.W.1. Tel.: Belgravia 7011. T.A.: Assoelect London. (424)

A.E.W., LTD., Imperial Works, High Street, Edgware, Middx. Tel.: Edgware 5278. T.A.: Furnedge Edgware. (356, 368, 384, 442)

A.I. ELECTRIC WELDING MACHINES, LTD., Grove House, Sutton New Road, Erdington, Birmingham, 23. Tel.: Erdington 1176. T.A.: Aiwelds Birmingham. (451)

A.K. FANS, LTD., 20 Upper Park Road, London, N.W.3. Tel.: Primrose 5969. T.A.: Akfans Haver London. (313)

A.N.T.E.X., LTD., 7-8 Idol Lane, London, E.C.3. Tel.: Mansion House 2716. T.A.: Antexlim. (356)

A.P.T. ELECTRONIC INDUSTRIES, LTD., 111 Chertsey Road, Byfleet, Surrey. Tel.: Byfleet 4411. T.A.: Aptran Byfleet. (356)

A.P.V. CO., LTD., THE, Manor Royal, Crawley, Sussex. Tel.: Crawley 1360. Telex: 8737. T.A.: Anaclastic Crawley. (323, 360, 413, 449)

A.P.V.-PARAMOUNT, LTD., Manor Royal, Crawley, Sussex. Tel.: Crawley 1360. T.A.: Paramount Crawley. (323, 413)

A.V.A., LTD., Thames Works, Lower Teddington Road, Hampton Wick, Nr. Kingston-on-Thames. Tel.: Teddington Lock 2201. (428)

ABBOFLEX, LTD., Walnut Tree Close, Guildford, Surrey. Tel.: Guildford 5893. T.A.: Abboflex Guildford. (446)

ABELSON AND CO. (ENGINEERS), LTD., Coventry Road, Sheldon, Birmingham, 26. Tel.: Sheldon 2424. T.A.: Abelson Birmingham. Cables: Abelson Birmingham. (408)

ABINGDON KING DICK, LTD., Abingdon Works, Kings Road, Tyseley, Birmingham, 11. Tel.: Acocks Green 2881. T.A.: Abingdon Tyseley Birmingham.

ABLE ENGINEERING CO., LTD., 12 Singer Street Chambers, Singer Street, London, E.C.2. Tel.: Clerkenwell 3695. (356)

ABRASIVE DEVELOPMENTS, LTD., High Street, Henley-in-Arden, Nr. Solihull, Warwick. Tel.: 104 and 160. T.A.: Autoflow Henley-in-Arden. (312)

ABRIL INDUSTRIAL WAXES, LTD., Bristol House, 18-23 Holborn Viaduct, London, E.C.1. Tel.: City 7037. T.A.: Abkdr Cent London. (396)

ACALOR (1948), LTD., Kelvin Way, Crawley, Sussex. Tel.: Crawley 1571. T.A.: Acalor Crawley. Cables: Acalor Crawley. (313, 353)

ACCESS EQUIPMENT, LTD., Maylands Avenue, Hemel Hempstead, Herts. Tel.: Boxmoor 5781. T.A.: Accesequip Hemel Hempstead. (361)

ACCLES AND POLLOCK, LTD., Oldbury, Birmingham. Tel.: Broadwell 1500. T.A.: Accles Oldbury Telex. (317, 338, 344, 413, 445, 446, 447, 453)

ACCLES AND SHELVOKE, LTD., Talford Street Works, Aston, Birmingham, 6. Tel.: Aston Cross 3277. T.A.: Acvoke Birmingham 6. (320)

ACCURATE RECORDING INSTRUMENT CO., Windsor Avenue, Merton, London, S.W.19. Tel.: Liberty 5661. T.A.: Accuracy London S.W.19. (337, 370, 384, 385, 425)

ACHESON COLLOIDS, LTD., P.O. Box No. 12, Prince Rock, Plymouth, Devon. Tel.: Plymouth 66351. T.A.: Oildag Plymouth. (374, 396)

ACME VENTILATING, LTD., Bradford Street, Walsall, Staffs. Tel.: Walsall 5183. T.A.: Acknight Walsall. (303, 354, 360, 403)

ACRU ELECTRIC TOOL MFG. CO., LTD., Demmings Road, Councillor Lane, Cheadle, Cheshire. Tel.: Gatley 6058. T.A.: Acrelect. (356)

ACTON, G., 73 King Street, Knutsford, Cheshire. Tel.: Knutsford 178. (320)

ADAMSON, DANIEL, AND CO., LTD., Engineering Works, Dukinfield, Cheshire. Tel.: Ashton-under-Lyne 2822. T.A.: Danadamson Dukinfield Telex. (313, 333, 360, 377, 424, 438, 445)

ADAMSON, JOSEPH, AND CO., LTD., P.O. Box 4, Hyde, Cheshire. Tel.: Hyde 2771. T.A.: Adamson Hyde. Cables: Adamson Hyde. (345, 360, 365)

ADCOCK AND SHIPLEY, LTD., P.O. Box 22, Ash Street, Leicester. Tel.: Leicester 24154. T.A.: Adcock Leicester. (398, 399)

ADCOLA PRODUCTS, LTD., Cauden Road, Clapham, London, S.W.4. Tel.: Macaulay 4272. T.A.: Soljoint London. (356)

ADVANCE COMPONENTS, LTD., Roebuck Road, Hainault, Ilford, Essex. Tel.: Hainault 4444. T.A.: Attenuate Ilford. (356, 385)

AEREX, LTD., 220 West Street, Sheffield, 1. Tel.: Sheffield 28441. T.A.: Aerex Sheffield Telex. (313)

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UNITED COKE AND CHEMICALS CO., LTD.
"Orkot" fabric reinforced resin bearings.

309 BELLOWS

AITON AND CO., LTD.
ANGUS, GEORGE, AND CO., LTD.
Synthetic rubber; "Belloframs".
APPLEBY AND IRELAND, LTD.
Bellows: stainless steel and monel; capsules and diaphragms, all materials.

309 BELLOWS (contd.)

ASHMORE, BENSON, PEASE AND CO., LTD.
AVICA EQUIPMENT, LTD.
Stainless steel for long life efficiency.
BEAKBANE, HENRY, (FORTOX), LTD.
Protecting.
CLARKE, CHAPMAN AND CO., LTD.
DRAYTON REGULATORS AND INSTRUMENT CO., LTD.
ENGINEERING APPLIANCES, LTD.
High pressure steel (A).
ENGLISH ELECTRIC CO., LTD., THE.
FIRESTONE TYRE AND RUBBER CO., LTD.
FAIRLEEDE ENGINEERING, LTD.
Fabricated mild steel and stainless steel.
LUCAS, JOSEPH, LTD.
S.s., nimonics.
MOFFAT ENGINEERING CO., LTD.
MUNRO AND MILLER, LTD.
" Bellex " expansion joints.
PLYSU PRODUCTS, LTD.
" Corrugaiters " p.v.c. bellows.
POWER FLEXIBLE TUBING CO., LTD., THE.
Flexible metallic.
TEDDINGTON AIRCRAFT CONTROLS, LTD.
S.s., inconel, monel, nimonic alloys, titanium.
WELDING TECHNICAL SERVICES, LTD.
Bellows in stainless steel and high nickel-alloys.
WILKINSON RUBBER LINATEX, LTD.
Flexible hoses, components, seals.

310 BERYLLIUM

T.I. NUCLEAR ENGINEERING, LTD.
Tube and rod.
BERK, F. W., AND CO., LTD.
Agent.
BERYLLIUM SMELTING CO., LTD.
Beryllium shapes, alloys, beryllia special alloys.
CHESTERFIELD TUBE CO., LTD., THE.
CONSOLIDATED BERYLLIUM, LTD.
Nuclear grade, water reactor alloys.
ENGLISH ELECTRIC CO., LTD., THE.
GLASS DEVELOPMENTS, LTD.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
NEW METALS AND CHEMICALS, LTD.
Metal and oxides.

311 BERYLLIUM MONITORS

NEW METALS AND CHEMICALS, LTD.
ULTRASONOSCOPE CO. (LONDON), LTD.
WINSTON ELECTRONICS, LTD.

312 BLASTING; Shot, Sand, Grit

ABRASIVE DEVELOPMENTS, LTD.
Machines, wet vapour; dry.
AIRNESCO PRODUCTS, LTD.
Mobile blasting equipment.
BAKER PERKINS, LTD.
BERK, F. W., AND CO., LTD.
BRISTOL METAL SPRAYING AND WELDING CO., LTD.
In shop or on site.
GRINDLAY, J., AND COY., LTD.
Open shot blasting and Vacublast process.
GUYSON INDUSTRIAL EQUIPMENT, LTD.
INDUSTRIAL PAINTING CONTRACTORS (WINCHESTER), LTD.
Sand or grit.
JACKMAN, J. W., AND CO., LTD.
Airless shot blasting equipment.
METAL DEPOSITS, LTD.
Contract shot.
METALLIZING EQUIPMENT CO., LTD.
Grit blasting for metal spraying.
METAL SPRAYERS, LTD.
Sand and grit.
PROTECTIVE RUBBER COATINGS (BRISTOL), LTD.
Shot, sand, grit blasting facilities.
SPENCER AND HALSTEAD, LTD.
RICHARDSON, R. J., AND SONS, LTD.
Shot (A).
RUSTON AND HORNSBY, LTD.
UNIVERSAL METAL SPRAYERS, LTD.
VACU-BLAST, LTD.
Machines, mobile, dust-free, shot.
YORKSHIRE METAL SPRAYERS, LTD.

313 BLOWERS; Circulators, Fans

A.K. FANS, LTD.
" Airmax " patented highest efficiency axial fans.
ACALOR (1948), LTD.
ADAMSON, DANIEL, AND CO., LTD.
AEREX, LTD.
High efficiency, axial, radial flow, standard and custom built.
AIR CONTROL INSTALLATIONS, LTD.
Fans, high pressure, induced draught, ventilating.
AIRSCREW CO. AND JICWOOD, LTD., THE.
Fan manufacturers, consultants and designers.
ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY), LTD.
Gas circulators, centrifugal.
BIVAC AIR CO., LTD.
Turbo; exhausters.
BLACKMAN, KEITH, LTD.
DAVIDSON AND CO., LTD.
DE HAVILLAND ENGINE CO., LTD., THE.
Circulators, gas bearing.
BRYAN DONKIN CO., LTD., THE.
High, low pressure.
DOWTY FUEL SYSTEMS, LTD.
EXTRUDEX, LTD.
FENTON, BYRN, AND CO., LTD.
GODFREY, SIR GEORGE, AND PARTNERS (INDUSTRIAL), LTD.
Positive displacement Roots, gas boosters.
HOLLAND, B. A., ENGINEERING CO., LTD., THE.
SLM blowers and boosters.
HOLMES, W. C., AND CO., LTD.
Positive air blowers.
HOWDEN, JAMES, AND CO., LTD.
Main circulators; biological shield cooling fans.
JENKINS, ROBERT, AND CO., LTD.
Circulator casings.
JOHNSTONE, ARCHIBALD, (ENGINEERS), LTD.
High pressure, induced draught.
MATTHEWS AND YATES, LTD.
Fans, centrifugal, axial, propeller, high efficiency, p.v.c., induced draught.
MIDLAND HEATING AND VENTILATING CO., LTD., THE.
NORTHEY ROTARY COMPRESSORS, LTD.
Rotary, lobe type, high pressure.
OWEN ORGANISATION, THE.
PARSONS, C. A., AND CO., LTD.
PULLIN, R. B., AND CO., LTD.
RICHARDSONS, WESTGARTH AND CO., LTD.
Centrifugal, axial flow.
RESISTANT EQUIPMENT, LTD.
Fans, p.v.c. and polythene.
SERVICE ELECTRIC CO., LTD.
Hot, cold, air, suction equipment, centrifugal, fans, sirens.
SIMON-CARVES, LTD.
Fans.
STANDARD AND POCHIN BROS., LTD., THE.
Centrifugal fans.
STURTEVANT ENGINEERING CO., LTD.
Fans, centrifugal, axial, propeller.
TANKS AND LININGS, LTD.
Fans, acid resisting, plastics.
WADE ENGINEERING, LTD.
Superchargers, air motors.
WALKER, P. M., AND CO. (HALIFAX), LTD.
Fans, propeller, centrifugal, axial flow.
X-LON PRODUCTS, LTD.
Plastics fans.

314 BORAL

HIGH DUTY ALLOYS, LTD.
Sheet.

315 BORON

BORAX AND CHEMICALS, LTD.
Compounds, oxides and metals.
BORAX CONSOLIDATED, LTD.
Elemental, metallic borides, borates, etc.
BROWN, JOHN, (S.E.N.D.), LTD.
HADFIELDS, LTD.
NEW METALS AND CHEMICALS, LTD.
Amorphous, high purity, electrolytic and boron carbide.
NORTON GRINDING WHEEL CO., LTD.
Boron carbide " Norbide ".
20th CENTURY ELECTRONICS, LTD.
Enriched in B-10 or B-11 isotope.

316 BRAKES; Clutches

M.T.E. CONTROL GEAR, LTD.
Electro-magnetic disc type.
BRITISH COMPRESSED AIR SOCIETY
BROADBENT, THOMAS, AND SONS, LTD.
BROOKHIRST IGRANIC, LTD.
Electro-magnetic brakes; magnetic and induction clutches.
CARTER, B. AND F., AND CO., LTD.
Centrifugal clutches.
CROFTS (ENGINEERS), LTD.
Industrial friction.
DEWHURST AND PARTNER, LTD.
Electromagnetic.
DUNLOP RUBBER CO., LTD.
Disc.
FERODO, LTD.
Brake, clutch linings, facings.
FLUIDRIVE ENGINEERING CO., LTD.
Synchro self-shifting.
GENERAL PRECISION SYSTEMS, LTD.
High speed bi-directional E.M. clutch.
LAYCOCK ENGINEERING, LTD.
NORTH BRITISH LOCOMOTIVE CO., LTD.
Manufacturers of torque convertors.
RAPID MAGNETIC, LTD.
SIMMONS ELECTRICAL AND WINDING CO., LTD.
Magnetic.
TWIFLEX COUPLINGS, LTD.
Industrial disc brakes, automatic clutches.
WESTOOL, LTD.
" Warner " electro-magnetic.
WIGGLESWORTH, F., AND CO., LTD.
Friction clutches.

317 BURST FUEL ELEMENT DETECTION

ACCLES AND POLLOCK, LTD.
ASSOCIATED ELECTRICAL INDUSTRIES, LTD. (Instrumentation division).
ELLIOTT NUCLEONICS, LTD.
Recorders.
FAIREY CO., LTD., THE.
HALL, MATTHEW AND CO., LTD.
IRWIN, E. G., AND PARTNERS, LTD.
Design and installation of detection equipment.
LANCASHIRE DYNAMO ELECTRONIC PRODUCTS, LTD.
Scanning control, count check, display and record.
PLESSEY CO., LTD.
PLESSEY NUCLEONICS, LTD.
Complete plant.
POWER AUXILIARIES, LTD.
SALFORD ELECTRICAL INSTRUMENTS, LTD.
Precipitators (fission product detection); rotary gas sampling valves.
TALBOT STEAD TUBE CO., LTD.
S.s. tubes.
TUBE PRODUCTS, LTD.
Tubes.
VICKERS-ARMSTRONGS (AIRCRAFT), LTD.

318 BUSHES

SPE CO., LTD.
Wedged key, split, plain, specials.
BARNABY ENGINEERING CO. (1950), LTD.
Temporary bearings for fuel element line up.
BIRFIELD INDUSTRIES, LTD.
Oil, P.t.f.e. impregnated.
BIRKETT, T. M., BILLINGTON AND NEWTON, LTD.
Precision machined.
BOUND BROOK BEARINGS, LTD.
Sintered porous bronze and iron graphited bronze; P.t.f.e. dry-lubricated.
GREASE APPLIANCE CO., LTD.
Nylon bushes.
HALL AND KAY, LTD.
HOLROYD, J., AND CO., LTD.
Bronze, plain.
LITHOLITE INSULATORS AND ST. ALBANS MOULDINGS, LTD.
Plastic mouldings.
MANGANESE BRONZE AND BRASS CO., LTD., THE.
Oilite self-lubricating bearings.
MORGAN CRUCIBLE CO., LTD., THE.
" Morganite " carbon.
RANSOME AND MARLES BEARING CO., LTD.
Linear ball.
SINTERED PRODUCTS, LTD.
Sintered metal.

319 CABINETS; Panels

A.C.M. ELECTRONICS, LTD.
Cabinets, panels, racks.
AUSTIN TAYLOR ELECTRICAL, LTD.
BATES BROS. (ENGINEERS), LTD.
BROOKHIRST IGRANIC, LTD.
BROWN, E. G., AND CO., LTD.
Instrument cabinets, racks and consoles.
BURNLEY AIRCRAFT PRODUCTS, LTD.
Sheet metal.
CHILTON ELECTRIC PRODUCTS, LTD.
Control, distribution panels.
DATUM METAL PRODUCTS, LTD.
Racks, consoles, cases, chassis.
DYNATRON RADIO, LTD.
Instrument cases, racks.
ELECTRICAL REMOTE CONTROL CO., LTD.
Control cubicle to customers' requirements.
ETHER, LTD.
FAIREY CO., LTD., THE.
Safety and control gear.
FARMER BROS. (SHIFNAL), LTD.
EDWARD FARR, LTD.
FAWCETT PRESTON AND CO., LTD.
FIBRECLAD, LTD.
Reinforced plastic.
FIELD AND GRANT, LTD.
Mimic diagrams, process control, special panels.
HAMBLING INDUSTRIES, LTD.
HASSETT AND HARPER, LTD.
Sheet metal, metal pressings.
HUTCHEON, DUTHIE R., AND SON, LTD.
INTEGRA LEEDS AND NORTHRUP, LTD.
Cabinets, panels, with complete instrumentation.
KENT, GEORGE, LTD.
LANCASHIRE DYNAMO NEVELIN, LTD.
LINTOTT, H. AND E., LTD.
LUND BROS. AND CO., LTD.
MAITLANDS (METAL WORKS), LTD.
MALONE INSTRUMENT CO., LTD., THE.
MARSH, H. S., LTD.
MILLETT, LEVENS (INSTRUMENTS AND ENGINEERING), LTD.

319 CABINETS; Panels (contd.)

MOORE'S (WALLISDOWN), LTD.
NEW WESTERN (ENGINEERING), LTD.
"Lockmet". "Lockplast" panels, cubicles.
ODDIE FASTENERS.
Quick release Oddie fasteners.
PHILLIPS AND BONSON, LTD.
RESISTANT EQUIPMENT, LTD.
P.v.c. fume and process.
RITHERDON AND CO., LTD.
ROBINSON, D., AND CO.
SEALEY ENGINEERING CO., LTD.
Specials to order.
SILENTBLOC, LTD.
Anti-vibration mountings, panel fasteners.
SOUTH WALES SWITCHGEAR, LTD.
TELEMETERS, LTD.
THORN ELECTRICAL INDUSTRIES, LTD.
UNIVERSAL BOILERS AND ENGINEERING CO., LTD.
Sheet metal.
UNIVERSAL PATTERN AND PRECISION ENGR. CO., LTD.
WILFLO PRODUCTS, LTD.
WINSTON ELECTRONICS, LTD.

320 CABLES, ELECTRIC; Accessories

E.R.S. (LONDON), LTD.
ACCLES AND SHELVOKE, LTD.
Acvoke cable spiking guns.
ACTON, G.
AERIALITE, LTD.
Plastics, rubber insulated: power.
ASSOCIATED ELECTRICAL INDUSTRIES, LTD. (Cable division)
BOWTHORPE ELECTRIC CO., LTD.
Overhead line fittings.
BRITISH DRIVER-HARRIS CO., LTD.
BRITISH INSULATED CALLENDER'S CABLES, LTD.
Variety, cabled copper tube, wire.
CROMPTON PARKINSON, LTD.
Paper, rubber, thermoplastic insulated.
DATUM METAL PRODUCTS, LTD.
"Datum" cable troughs.
DAY, J., AND CO. (DERBY WORKS), LTD.
P.v.c.; wires and multicores.
DURATUBE AND WIRE, LTD.
ERMA, LTD.
Terminals; lugs, crimping tools; wire strippers.
FARNELL INSTRUMENTS, LTD.
GEIPEL, WILLIAM, LTD.
GENERAL CABLE MANUFACTURING CO., LTD., THE.
Rubber, synthetic rubber, thermoplastic cables.
GIRDLESTONE PUMPS, LTD.
Co-axial connectors.
HAMBLING INDUSTRIES, LTD.
HAWNT AND CO., LTD.
HELLERMAN, LTD.
HELLERMANN, LTD.
Overhead line fittings.
JOHNSON AND PHILLIPS, LTD.
LIVERPOOL ELECTRIC CABLES CO., LTD.
MERSEY CABLE WORKS, LTD.
Rubber, A.I.D., A.R.B. plastic, varnished, irradiated, polythene.
MILES-HIVOLT, LTD.
Cable testing equipment.
PERMANOID, LTD.
PLESSEY CO., LTD.
Pre-formed wiring systems, electrical connectors.
PYROTENAX, LTD.
Pyrotenax mineral insulated.
SAXONIA ELECTRICAL WIRE CO., LTD., THE.
TELEGRAPH CONSTRUCTION AND MAINTENANCE CO., LTD.
UNISTRUT DIVISION OF SANKEY SHELDON, LTD.
Cable and conduit supports.
WANDLESIDE CABLE WORKS, LTD.
P.t.f.e., p.t.f.e./glass insulated high temperature.
WARD AND GOLDSTONE, LTD.
YORKSHIRE IMPERIAL METALS, LTD.
Cable sockets.

321 CARBON DIOXIDE

DISTILLERS CO., LTD., THE.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
POWER-GAS CORPORATION, LTD.

322 CARBON DIOXIDE PLANT

A.E.I.-BIRLEC, LTD.
Dryers.
P.G. ENGINEERING, LTD.
DISTILLERS CO., LTD., THE.
HEAD WRIGHTSON PROCESSES, LTD.
Carbon dioxide plant.
HOLMES, W. C., AND CO., LTD.
Storage and vaporizing plant.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
INCANDESCENT HEAT CO., LTD., THE.
LLOYD AND ROSS, LTD.
YORK SHIPLEY, LTD.

323 CASTINGS

A.P.V.-PARAMOUNT, LTD., THE.
Stainless steel and special alloys.
K. AND L. STEELFOUNDERS AND ENGINEERS, LTD.
ALLEN, EDGAR, AND CO., LTD.
Carbon, alloy, highly alloyed steels.
ANDREWS, HAROLD, SHEEPBRIDGE, LTD.
Cylinders, continuously cast iron bar.
ANTI-ATTRITION METAL CO., LTD.
ASHMORE, BENSON, PEASE AND CO., LTD.
High duty, meehanite iron and spheroidal graphite castings.
ATLAS STEEL FOUNDRY AND ENGINEERING CO., LTD., THE.
BARNSLEY, JOHN, AND SONS, LTD.
Grey, malleable iron, steel, non-ferrous.
BEARDMORE, WILLIAM, AND CO., LTD.
BENNIS COMBUSTION, LTD.
Grey alloy, high duty iron.
BIRFIELD INDUSTRIES, LTD.
Aluminium, magnesium, bronze malleable iron.
BIRKETT, T. M., BILLINGTON AND NEWTON, LTD.
Non-ferrous and high duty iron. Shell moulded.
BIRMINGHAM ALUMINIUM CASTING (1903) CO., LTD.
BLUNDELL AND CROMPTON, LTD.
BROADS MANUFACTURING CO., LTD.
Manhole, access, duct covers; drainage fittings.
BROWN, DAVID, CORPORATION (SALES), LTD., THE.
Alloy and carbon steel, bronze.
BROWN, JOHN, (S.E.N.D.), LTD.
Iron.
BUTTERLEY CO., LTD., THE.
Meehanite iron to 20 tons.
CAMERON AND ROBERTON, LTD.
Meehanite to 1 ton; patterns.
COCKBURNS, LTD.
Non-ferrous castings to 15 cwt.
CONSTRUCTIONAL ENGINEERING CO., LTD., THE.
COWANS, SHELDON AND CO., LTD.
Grey iron up to 8 tons. Non-ferrous.
CRAVEN BROTHERS (MANCHESTER), LTD.
To 40 tons; non-ferrous
DARLINGTON FORGE, LTD., THE.
Steel, up to 75 tons.
DARWINS, LTD.
DAVISON AND CO. (HEXHAM), LTD.
DELORO STELLITE, LTD.
Heat, corrosion and abrasion resistant.
DEWRANCE AND CO., LTD.
(Bronze) safety relief valves.
DIALOY, LTD.
DISTINGTON ENGINEERING CO., LTD.
Medium/heavy iron castings.
ENGLISH ELECTRIC CO., LTD., THE.
ENGLISH STEEL CASTINGS CORPORATION, LTD.
Steel up to 185 tons individual weight.
ENTWISLE AND GASS, LTD.
FAIREY CO., LTD., THE.
Investment castings.
FIRTH, THOS., AND JOHN BROWN, LTD.
Carbon and alloy steel castings.
FIRTH-VICKERS STAINLESS STEELS, LTD.
Alloy, s.s.; precision, static, shell moulded.
FOLLSAIN-WYCLIFFE FOUNDRIES, LTD.
Abrasion resisting, high duty, heat-resisting steel.
FROST, H., AND CO., LTD.
Diecastings, zinc alloy.
GRANGE-CAMELON IRON CO., LTD.
Engineering and general; ¼ lb to 2½ cwt.
GRAZEBROOK, M. AND W., LTD.
Heavy, iron.
GUEST INDUSTRIALS, LTD.
Steel, agents for S.I.A.C.
HADFIELDS, LTD.
Steel.
HARLAND AND WOLFF, LTD.
Ferrous 100 tons; s.g. iron, non-ferrous.
HARPER, JOHN, AND CO., LTD.
HEPWORTH AND GRANDAGE, LTD.
HIGH DUTY ALLOYS, LTD.
Aluminium alloys.
HOLMAN BROS., LTD.
Meehanite.
HOLROYD, J., AND CO., LTD.
Phosphor bronze.
HOPKINSONS, LTD.
Castings steel, heat-resisting.
INCANDESCENT HEAT CO., LTD., THE.
Grey iron; and nickel chromium.
INTERNATIONAL MEEHANITE METAL CO., LTD., THE.
JACKMAN, J. W., AND CO., LTD.
JESSOP-SAVILLE, LTD.
Constructional; steel, s.s.
LAKE AND ELLIOT, LTD.
Carbon, chrome, molybdenum, s.s.; s.g. cast iron.
LANGLEY ALLOYS, LTD.
S.s., nickel alloys.
LAYCOCK ENGINEERING, LTD.
LE GRAND SUTCLIFF AND GELL, LTD.
LLOYD, F. H., AND CO., LTD.
Carbon, alloy steel, s.g. to 25 tons; unmachined, machined.
LONDON METAL WAREHOUSES, LTD.
LOW, ARCHIBALD, AND SONS, LTD.
METROPOLITAN PLASTICS, LTD.
Zinc, alloy, press or die.
MILLSPAUGH, LTD.
MOFFAT ENGINEERING CO., LTD.
OSBORN, SAMUEL, AND CO., LTD.
OWEN ORGANISATION, THE.
Non-ferrous, aluminium gravity die, iron up to 30 cwt., chill cast phosphor bronze rods.
OXLEY, WM., AND CO., LTD.
Stainless steel.
PHOSPHOR BRONZE CO., LTD., THE.
RHODES, B., AND SON, LTD.
Pure nickel, monel, nickel alloy; machined.
RHYMNEY ENGINEERING CO., LTD.
Light, medium, heavy. Design facilities.
RYDER, THOS., AND CO. (MANCHESTER), LTD.
G.M. phos. mang. bronze, C.I., pure aluminium.
SANDFORD, THOMAS, (ROCHDALE), LTD.
SHEEPBRIDGE ALLOY CASTINGS, LTD.
Corrosion and heat resisting steel.
SHEEPBRIDGE EQUIPMENT, LTD.
Iron, alloy, s.g. iron to 10 tons; steel to 35 cwt.
SHEEPBRIDGE STOKES, LTD.
Cylinders, s.g. iron, Loded Centricast, Centrard, Hi-Ten.
SLOUGH METALS, LTD.
Sand, die castings in aluminium, gunmetal, lead.
SMITH, W. H., AND CO. (WHITCHURCH), LTD.
STEEL CO. OF SCOTLAND, LTD.
STERLING METALS, LTD.
Aluminium and magnesium alloy.
STEWARTS AND LLOYDS, LTD.
SUTCLIFFE, SPEAKMAN AND CO., LTD.
Heat resisting.
TANGYES, LTD.
High quality grey "Tangye" iron.
TERRASPAN, LTD.
TEES SIDE BRIDGE AND ENGINEERING WORKS, LTD.
Heat-resisting and grey iron.
THOMPSON, JOHN, LTD.
WALKER, C. AND W., LTD.
Ferrous.
WIDNES FOUNDRY AND ENGINEERING CO., LTD.
Cast iron irradiated element containers.
WILLAN, G. L., (CASTINGS), LTD.
Stainless and heat resisting castings.
WILSON PIPE FITTINGS, LTD.
Aluminium, pressure, die, gravity, sand, (A).

324 CENTRIFUGES

ALFA-LAVAL CO., LTD.
BAIRD AND TATLOCK (LONDON), LTD.
BROADBENT, THOMAS, AND SONS, LTD.
FARNELL INSTRUMENTS, LTD.
GRIFFIN AND GEORGE (SALES), LTD.
HOPKINSONS, LTD.
Centrifuges, oil separators.
KILPATRICK, JAMES, AND SON, LTD.
SHANDON SCIENTIFIC CO., LTD.
Laboratory centrifuges.
SHARPLES CENTRIFUGES, LTD.
SIMMONS ELECTRICAL AND WINDING CO., LTD.
Limit.
TOWERS, J. W., AND CO., LTD.
Laboratory.
VICKERYS, LTD.
Filters, classifiers, mineral separators.

325 CERAMICS

AEROX, LTD.
AUTOFLOW ENGINEERING, LTD.
Grinding and cutting machines.
BOULTON, WILLIAM, LTD.
BRAY, GEORGE, AND CO., LTD.
Electro-ceramic insulators in Steattite and other materials.
BRISTOL METAL SPRAYING AND WELDING CO., LTD.
Sprayed coatings of ceramics, zirconia and alumina.
BUSH BEACH AND SEGNER BAYLEY, LTD.
Sintered, alumina, zirconia, magnesia.
CARTER TILES, LTD.
Glazed and unglazed tiles.
DOULTON INDUSTRIAL PORCELAINS, LTD.
Piping, cocks, pumps, vessels.
ENDECOTTS (FILTERS), LTD.
Test sieving equipment.
ENGLISH STEEL TOOL CORPORATION, LTD.
Cutting tools.
FERRO ENAMELS, LTD.
Special refractories.
HATHERNWARE, LTD.
Chemical stoneware, porcelain.
HYDRONYL SYNDICATE, LTD., THE.
Catalysts carriers, support balls.
LANGLEY, LONDON, LTD.
Tiles for cooling ponds, decontamination and incinerator buildings, etc.
LODGE PLUGS, LTD.
"Sintox" alumina ceramics.
METALLIZING EQUIPMENT CO., LTD.
Ceramic flame spraying equipment and supplies.
MORGAN REFRACTORIES, LTD.
Structural refractories; furnace tubes; pyrometer sheaths; oxide ware.

325 CERAMICS (contd.)

NORTH BRITISH STEEL FOUNDRY, LTD., THE.
Fettled or machined steel castings up to 10 tons
NORTON GRINDING WHEEL CO., LTD.
Porous media and high temperature refractories.
PLESSEY CO., LTD.
Valveholders, low loss components, solid state transducers, capacitors.
ROYAL WORCESTER INDUSTRIAL CERAMICS, LTD.
Aluminium oxide and non-felspathic porcelain rods, tubes, formers.
TAYLOR, TUNNICLIFF AND CO., LTD.
Electrical insulation, capacitor dielectrics, etc.
TELEGRAPH CONDENSER CO., LTD., THE.
UNITED INSULATOR DIVISION OF T.C.C.
Insulating, dielectric and piezoelectric.

326 CHARGE/DISCHARGE GEAR

BRISTOL SIDDELEY ENGINES, LTD.
Recirculating ball lead screws.
BROWN, JOHN (S.E.N.D.), LTD.
Machines and ancillaries.
ENGLISH ELECTRIC CO., LTD., THE.
Complete equipment.
FAIREY CO., LTD., THE.
FLIGHT REFUELLING, LTD.
Standpipe self-locking closures and grabs.
GEARTIGHT UNIONS, LTD.
HALL ENGINEERING, LTD.
Charge tubes, irradiation flux scanner tubes.
HALL, MATTHEW AND CO., LTD.
MALLINSON, WILLIAM, AND SONS, LTD.
Hydrobord neutron shielding.
METRO-FLEX ATOMIC ENGINEERING, LTD.
Gas-tight sealing.
NAPIER, D., AND SON, LTD.
NEWBURGH ENGINEERING CO., LTD.
POWER AUXILIARIES, LTD.
RICHARDS AND ROSS, LTD.
Standpipes, charge tubes.
TALBOT STEAD TUBE CO., LTD.
UNIT SUPERHEATER AND PIPE CO., LTD., THE.
Reactor standpipes.
VICKERS-ARMSTRONGS (ENGINEERS), LTD.

327 CHARGE PANS

ASHMORE, BENSON, PEASE AND CO., LTD.
ENGLISH ELECTRIC CO., LTD., THE.
FAIREY CO., LTD., THE
Fabricated.
FAIRLEEDE ENGINEERING, LTD.
HALL ENGINEERING, LTD.

328 CHEMICALS; Gases

P.G. ENGINEERING, LTD.
Inert gases, hydrogen.
BRITISH DRUG HOUSES, LTD.
BRITISH OXYGEN GASES, LTD.
DISTILLERS CO., LTD., THE.
GURR, EDWARD, LTD.
Biological stains.
HOLMES, W. C., AND CO., LTD.
Inert gas/nitrogen generators.
HOPKIN AND WILLIAMS, LTD.
Chemicals for research and analysis.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
INCANDESCENT HEAT CO., LTD., THE.
Plants for generation of hydrogen, nitrogen, carbon dioxide, fuel gas from oil, ammonia crackers.
INTERNATIONAL ELECTROLYTIC PLANT, LTD., THE.
LUNEVALE PRODUCTS, LTD.
Organo-mercurial compounds.
MONSANTO CHEMICALS, LTD.
NASH AND THOMPSON, LTD.
Scintillation purity.
NUCLEAR CHEMICAL PLANT, LTD.
Irradiated element processing.
PAGE, CHAS., AND CO., LTD.
(A).
POWER-GAS CORPORATION, LTD.
SATURN INDUSTRIAL GASES, LTD.
TEXAS INSTRUMENTS, LTD.
Hyperpure silicon.
THOMPSON AND CAPPER, LTD.
Catalysts, tabletting, peletting service.

329 CIVIL CONTRACTORS

M.B. DREDGING CO., LTD.
CEMENTATION CO., LTD.
CHIVERS, W. E., AND SONS, LTD.
COLLINS SUBMARINE PIPELINES, LTD.
Submarine pipe laying.
COSTAIN, RICHARD, LTD.
DEMOLITION AND CONSTRUCTION CO., LTD., THE.
DURHAM, GORDON, AND CO., LTD.
FITZPATRICK AND SONS (CONTRS.), LTD.
FORD AND WALTON, LTD.
GAYLORD, EDWARDS AND CO., LTD.
GEE, WALKER AND SLATER, LTD.
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HARBOUR AND GENERAL WORKS, LTD.
HEPBURN BROS., LTD.
Public works contractors.
HOLLOWAY BROS. (LONDON), LTD.
LAING, JOHN, AND SON, LTD.
LENANTON, JOHN, AND SON, LTD.
Timber merchants.
McALPINE, SIR ROBERT, AND SONS, LTD.
MACKLEY, J. T., AND CO., LTD.
Steel piling, a.c. piling, efficient outfalls, etc.
MANCHESTER SLATE CO., LTD.
Roofing, cladding and structural insulation.
MARSHALL SONS AND CO., LTD.
MEARS BROS. (CONTRACTORS), LTD.
MOTOR RAIL, LTD.
MOUNT CONSTRUCTION, LTD.
MOWLEM, J., AND CO., LTD.
NUCLEAR CIVIL CONSTRUCTORS.
NUCLEAR CONSTRUCTIONS, LTD.
PRESS, WILLIAM, AND SON, LTD.
SIMON-CARVES, LTD.
STEPHENSON, G. (BUILDERS AND CONTRACTORS), LTD.
STEWART, THOMAS C., (CONTRACTORS), LTD.
STIRLING, J. A., LTD.
TAYLOR WOODROW CONSTRUCTION, LTD.
Building and civil engineering contractors.
TERRAPIN, LTD.
Multi-purpose, prefabricated pack buildings.
TODD AND CO. (CONTRACTORS), LTD.
Sewerage schemes, roadworks, tarmacadam.
TRENTHAM, G. PERCY, LTD.
TURRIFF CONSTRUCTION CORPORATION, LTD.
WEST'S PILING AND CONSTRUCTION CO., LTD.
WIMPENNY, J., AND CO., LTD.
Building and civil engineering contractors.
WOOD, PRITCHETT AND PARTNERS, LTD.
WYCOMBE HIRE PLANT
Mechanical plant for civil construction.

330 CLEANING; Descaling

C.P. EQUIPMENT, LTD.
C.P.-Sellers hot water high pressure jet and automatic tank cleaners.
H.N. ELECTRICAL SUPPLIES, LTD.
AIRNESCO PRODUCTS, LTD.
Cleaning with air/water, venturi gun.
ANGLO ABRASIVE WORKS, LTD.
BASTIAN AND ALLEN, LTD.
Speedyjet electric steam cleaners.
BIVAC AIR CO., LTD.
Portable industrial vacuum cleaners.
CLENSOL, LTD.
Descaling, derusting, degreasing chemicals.
CONSOLIDATED PNEUMATIC TOOL CO., LTD.
Air-driven Lagonda tube cleaners.
DAWE INSTRUMENTS, LTD.
Ultrasonic.
DENDIX BRUSHES, LTD.
Rotary maintenance brushes.
FOX CHEMICAL ENGINEERING WORKS, LTD.
GEM POWER BRUSHES, LTD.
Rotary, hand, industrial wire brushes.
GENERAL DESCALING CO., LTD.
Equipment, service, pipeline, duct, sewer.
HOPKINS, G., AND SONS, LTD.
General purpose ultrasonic washing machines.
HOUSEMAN AND THOMPSON, LTD.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
Degreasing plants and solvent alkaline degreasing agents.
INDUSTRIAL DESCALING TOOLS, LTD.
Compressed air and electrically driven machines and accessories for descaling.
KLEEN-E-ZE-BRUSH CO., LTD., THE.
Bullets, guns, for condenser cleaning.
MORRIS, B. O., LTD.
MULLARD EQUIPMENT, LTD.
Ultrasonic decontamination.
SERVICE ELECTRIC CO., LTD.
Industrial vacuum cleaners.
SPENCER AND HALSTEAD, LTD.
ULTRASONICS, LTD.
Ultrasonic.
VACU-BLAST, LTD.
Pipe, weld, in-situ blasting of large fabrications.
WOLF ELECTRIC TOOLS, LTD.
Portable electric, sanders.

331 CLEAN ROOMS

B.M.B. (SALES), LTD.
CRAVENS, LTD.
Facilities.
HALL ENGINEERING, LTD.
INTERNATIONAL ENGINEERING CONCESSIONAIRES, LTD.
MEAKES, J. G., LTD.
Perspex boxes for use in clean conditions.
NEW WELBECK, LTD.
Protection machines.
UNIVERSAL PATTERN AND PRECISION ENGR., CO., LTD.

332 COLUMNS, CHEMICAL

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APEX CONSTRUCTION, LTD.
Fractionating, evaporating, solvent recovery.
ASHMORE, BENSON, PEASE AND CO., LTD.
BALFOUR, HENRY, AND CO., LTD.
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DAVEY, PAXMAN AND CO., LTD.
Chemical separation.
FAIRLEEDE ENGINEERING, LTD.
GLASS DEVELOPMENTS, LTD.
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HEAD WRIGHTSON PROCESSES, LTD.
HEAT TRANSFER, LTD.
Chemical separation.
HOLMES, W. C., AND CO., LTD.
HYDRONYL SYNDICATE, LTD., THE.
Packings, tower, liquid-liquid, gas absorption.
JENKINS, ROBERT, AND CO., LTD.
KNITMESH, LTD.
Packings.
MAITLANDS (METAL WORKS), LTD.
MARSTON EXCELSIOR, LTD.
Light alloy and non-ferrous metals.
PEABODY, LTD.
Columns for gas absorption and stripping.
SHEEPBRIDGE EQUIPMENT, LTD.
Steel, all types.
SIMON-CARVES, LTD.
STERLING INSTRUMENT CO., LTD.
VICKERS-ARMSTRONGS (ENGINEERS), LTD.
WRIGHTS FORGE AND ENG. CO., LTD.

333 COMPRESSORS

B.E.N. PATENTS, LTD.
Air.
C.T. (LONDON), LTD.
Glandless and leakproof.
KSB MANUFACTURING CO., LTD.
Rotary.
ADAMSON, DANIEL, AND CO., LTD.
AIR PUMPS, LTD.
Portable, stationary.
ALLEY AND MACLELLAN (POLMADIE), LTD.
Air and gas.
ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY), LTD.
ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY), LTD.
Centrifugal.
ATLAS COPCO (GREAT BRITAIN), LTD.
BLACKMAN, KEITH, LTD.
BROOM AND WADE, LTD.
Air; portable, stationary.
BROTHERHOOD, PETER, LTD.
Air, gas.
CENTRAX, LTD.
Compressor, turbine blades.
CONSOLIDATED PNEUMATIC TOOL CO., LTD.
Portable to 600 c.f.m. stationary to 5,000 c.f.m.
CUTT, J. AND K. K., LTD.
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DONKIN, BRYAN CO., LTD., THE.
DOUGLAS, WILLIAM, AND SONS (ENGINEERING), LTD.
DOWTY FUEL SYSTEMS, LTD.
DUNLOP RUBBER CO., LTD.
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GOODWIN, ARNOLD, LTD.
GUYSON INDUSTRIAL EQUIPMENT, LTD.
HAMWORTHY ENGINEERING, LTD.
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HARLAND AND WOLFF, LTD.
Gas.
HICK HARGREAVES AND CO., LTD.
Rotary.
HOLLAND, B. A., ENGINEERING CO., LTD. THE.
SLM rotary air and gas compressors.
HOLMAN BROS., LTD.
Portable, stationary, reciprocating, rotary.
HYDRAULICS AND PNEUMATICS, LTD.
Hydr. and pneu. comp., cycl. power units.
INGERSOLL RAND CO., LTD.
JOY-SULLIVAN, LTD.
LACY-HULBERT AND CO., LTD.
Air, reciprocating, non-lubricated rotary.
LIGHTFOOT REFRIGERATION CO., LTD., THE.
Freon, ammonia.
MACKAY INDUSTRIAL EQUIPMENT, LTD.
Free-piston compressors.
NAPIER, D., AND SON, LTD.
Fans, high pressure.
NORTHEY ROTARY COMPRESSORS, LTD.
OWEN ORGANISATION, THE.
All types.
REAVELL AND CO., LTD.
Oil-free, air, gas.
RICHARDSON, R. J., AND SONS, LTD.
(A).
RICHARDSONS, WESTGARTH AND CO., LTD.
Centrifugal, axial flow.
ROTAX, LTD.
Portable.
SEAGERS, LTD.
High pressure, air, industrial gases.
SHORROCK SUPERCHARGERS, LTD.

333 COMPRESSORS (contd.)

STOVIS ENGINEERING CO., LTD.
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STURDY ELECTRIC CO., LTD.
SULZER BROS. (LONDON), LTD.
TECALEMIT, LTD.
Air.
TEDDINGTON INDUSTRIAL EQUIPMENT, LTD.
Engine and compressor protection equipment.
THOMPSON BROS. (BILSTON), LTD.
WILD, THOS. C., (MACHINERY), LTD.
Air (A).
WILLIAMS AND JAMES (ENGINEERS), LTD.
Oil-free compressors and high pressure to 8,000 p.s.i.
WILSON, ALEXANDER, (ABERDEEN), LTD.
WORTHINGTON-SIMPSON, LTD.
Reciprocating, rotary, oil-free.
YORK SHIPLEY, LTD.
Refrigeration.

334 COMPUTERS

K.G.M. ELECTRONICS, LTD.
Read-out units.
R.C.A. (GREAT BRITAIN), LTD.
Computer including valves and transistors, etc.
ARCHIMEDES DIEHL MACHINE CO., LTD.
Diehl desk calculators (A).
ARMSTRONG WHITWORTH EQUIPMENT.
Digit print-out equipment.
ASSOCIATED ELECTRICAL INDUSTRIES, LTD.
Data-processing.
ASSOCIATED ELECTRICAL INDUSTRIES, LTD. (Electrical Apparatus Division).
Data handling equipment.
ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY), LTD. (Electronics Apparatus Division).
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Calculating machines.
CABLEFORM, LTD.
DECCA RADAR, LTD.
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DOBBIE McINNES (ELECTRONIC), LTD.
ELLIOTT NUCLEONICS, LTD.
Analogue, digital; data handling equipment.
ENGLISH ELECTRIC CO., LTD., THE.
Machines, facilities.
EVERSHED AND VIGNOLES, LTD.
Analogue.
FAIREY CO., LTD., THE.
Analogue, reactor simulators.
GENERAL PRECISION SYSTEMS, LTD.
D.C. and mechanical, analogue, components, power station simulators.
HAWKER SIDDELEY JOHN BROWN NUCLEAR CONSTRUCTION, LTD.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
Digital and analogue facilities available.
HONEYWELL CONTROLS, LTD.
Reactor simulator (U.S.A. mfr.).
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INTERNATION COMPUTERS AND TABULATORS, LTD.
Electronic digital calculators, computers and data processing equipment.
LANGHAM THOMPSON, J., LTD.
Digital counting equipment.
LINDARS AUTOMATION, LTD.
LINTRONIC, LTD.
Covertors, stores.
LUCAS, JOSEPH, LTD.
Analogue; simulators.
METAL GRAVURE CO., LTD., THE.
MILES ELECTRONICS, LTD.
NASH AND THOMPSON, LTD.
Analogue, special purpose and digital bricks.
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National-Elliott 802 desk digital.
PEEBLES, BRUCE, AND CO., LTD. (Electronics Division).
Complete range of analogue units.
PLESSEY CO., LTD.
Memory cores, planes and stores only.
ROBINSON, F. C., AND PARTNERS, LTD.
Transformer analogue network analyser.
SALFORD ELECTRICAL INSTRUMENTS, LTD.
Flux plotting equipment.
SAUNDERS-ROE, LTD.
Analogue.
SOLARTRON ELECTRONIC GROUP, LTD.
Analogue, reactor simulation, transfer function analyser, process response analyser.
SOUTHERN INSTRUMENTS, LTD.
Data reduction handling equipment.
SHORT BROS. AND HARLAND, LTD.
General purpose analogue. "Simlac" high-accuracy multi-unit analogue.
THORN ELECTRICAL INDUSTRIES, LTD.
WHITE AND RICHES, LTD.
Systems design.
WINSTON ELECTRONICS, LTD.

335 CONCRETE

CHEMICAL BUILDING PRODUCTS, LTD.
Waterproofers, plasticisers, accelerators.
ENDECOTTS (FILTERS), LTD.
Test sieving equipment.
EXPANDED METAL CO., LTD., THE.
Reinforcement.
FIBRECLAD, LTD.
Plastic moulds for concrete.
HALL ENGINEERING, LTD.
UNISTRUT DIVISION OF SANKEY SHELDON, LTD.
Concrete inserts for supporting all services.
LAFARGE ALUMINOUS CEMENT CO., LTD.
Ciment fondu high alumina cement; secar 250 white calcium, aluminate cement.
THE LIVERSEDGE REINFORCED CONCRETE ENGINEERING CO., LTD.
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Plyform and sealface plywood shutters.
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SINEX ENGINEERING CO., LTD.
Special high-density concrete vibrators.
VALE, THOMAS, AND SONS, LTD.
Reinforced concrete, structures (construction and design), general civil engineering, piling, etc.

336 CONSULTING SPECIALISTS

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Gyroscopic instrumentation.
EWBANK AND PARTNERS, LTD.
EXPANDED METAL CO., LTD., THE.
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FRASER, W. J., AND CO., LTD.
Nuclear chemical plants, effluent handling.
FULMER RESEARCH INSTITUTE, LTD.
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HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
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HYGROTHERM ENGINEERING, LTD.
Indirect heat transfer.
IRWIN, E. G., AND PARTNERS, LTD.
Project study, design, procurement, inspection.
KENNEDY AND DONKIN.
LIVERSEDGE REINFORCED CONCRETE ENGINEERING CO., LTD., THE
Structural designers and consultants.
MERZ AND McLELLAN.
MOFFAT ENGINEERING CO., LTD.
MOUCHEL, L. G., AND PARTNERS.
Consulting civil engineers.
NORTH WEST MACHINE DESIGN CO., LTD.
Design, development and manufacturing engineers.
NUCLEAR CHEMICAL PLANT, LTD.
Design and development of irradiated element processing plant.
PALATINE (SURBITON), LTD.
PLANER, G. V., LTD.
Electrical materials, components.
SITE INVESTIGATIONS CO., LTD.
Geological, geophysical, radiometric surveys and assays.
TELECOMMUNICATION INSTRUMENTS, LTD.
Data handling, process control systems.
THERMOTANK, LTD.
Air conditioning equipment.
VACUUM RESEARCH (CAMBRIDGE), LTD.
High vacuum.

337 CONTROL, REMOTE

E.M.B. CO., LTD.
P.A.M., LTD.
ACCURATE RECORDING INSTRUMENT CO.
Pressure switches.
APPLEBY AND IRELAND, LTD.
Control, remote reading.
ARENS CONTROLS, LTD.
Remote push-pull and transmission.
ARMSTRONG PATENTS CO., LTD.
ARMSTRONG-WHITWORTH EQUIPMENT.
Telemetry systems with remote supervision.
ASSOCIATED ELECTRICAL INDUSTRIES, LTD. (Instrumentation division).
BOWDEN (ENGINEERS), LTD.
Bowdenite light/heavy duty precision assemblies.
BRITISH ARCA REGULATORS, LTD.
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BROWN, S. G., LTD.
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Pneumatic devices; purpose-designed, manufactured.
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ELECTROFLO METERS CO., LTD.
ENGLISH ELECTRIC CO., LTD., THE.
EVERSHED AND VIGNOLES, LTD.
EXACTOR, LTD.
Hydraulically-operated remote controls.
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Remote handling equipment, remote machining equipment.
FARNELL INSTRUMENTS, LTD.
GLOBE PNEUMATIC ENG. CO., LTD., THE.
Remotely controlled radial type air motors.
GORDON, JAMES, VALVES, LTD.
Remote control of main CO2 and by-pass valves.
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Relays and contactors.
HOLMAN BROS., LTD.
Maxam fluid power equipment.
HONEYWELL CONTROLS, LTD.
HUNT AND MITTON, LTD.
Hydraulic, pneumatic.
IRWIN, E. G., AND PARTNERS, LTD.
Design of remote control systems.
LANCASHIRE DYNAMO ELECTRONIC PRODUCTS, LTD.
Speed, position, hand, tape, or other input.
LEE, GUINESS, LTD.
LUCAS, JOSEPH, LTD.
Hydraulic, pneumatic.
MANN, ALBERT, ENGINEERING CO., LTD.
MIDLAND ELECTRIC MANUFACTURING CO., LTD.
MILES DEVELOPMENT PRODUCTS, LTD.
Remote control.
NELSON, W. AND H., LTD.
NUMATION VALVES, LTD.
PEEBLES, BRUCE, AND CO., LTD. (Electronics division).
All kinds including by radio link.
PULLIN, R. B., AND CO., LTD.
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Mechanical, electrical, hydraulic, pneumatic, design facilities.
ROBINSON, D., AND CO.
Including control over P.O. lines.
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SCREW MACHINE PRODUCTS, LTD.
Components.
SEALEY ENGINEERING CO., LTD.
Systems to order.
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SQUARE D., LTD.
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VICKERS-ARMSTRONGS (AIRCRAFT), LTD.
WALKER, C. AND W., LTD.
WHITEHEAD, J., ENGINEERING (WILLESDEN), LTD.

338 CONTROL RODS

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ACCLES AND POLLOCK, LTD.
ASSOCIATED ELECTRICAL INDUSTRIES, LTD., Electronic Apparatus division.
Actuating mechanisms, control gear.
BORAX AND CHEMICALS, LTD.
Europium, Dysprosium, Gadolinium, Samarium, Erbium.
BRAMAH, J. R., AND CO., LTD.
BRISTOL SIDDELEY ENGINES, LTD.
BROWN, JOHN, (S.E.N.D.), LTD.
Mechanisms.
ELLIOTT NUCLEONICS, LTD.
Actuating mechanisms.
ENGLISH ELECTRIC CO., LTD., THE.
FAIREY CO., LTD., THE.
Flattening bars.
FIRTH CLEVELAND INSTRUMENTS, LTD.
Mechanisms.
FLETCHER, C. W., AND SONS, LTD.
HADFIELDS, LTD.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
HOBSON, H. M., LTD.
Signal arm, rods, gearboxes.
NAPIER, D., AND SON, LTD.
Mechanisms.
RENOLD CHAINS, LTD.
Suspension chains.
ROTAX, LTD.
Recirculating ball threads.
SALFORD ELECTRICAL INSTRUMENTS, LTD.
Mechanisms and position indication.
SCREW MACHINE PRODUCTS, LTD.
Components.
STEWARTS AND LLOYDS, LTD.
Standpipes for control rods.
TALBOT STEAD TUBE CO., LTD.
VICTOR ELECTRICS, LTD.
WALKER, C. AND W., LTD.
Tanks, vessels, c.i. steel.
WESTERN DETAIL MANUFACTURERS, LTD.

339 CONTROL ROD DRIVES

ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY), LTD., Electronic Apparatus division.
Actuator mechanisms control systems.
BRITISH COMPRESSED AIR SOCIETY.
ELECTRO-HYDRAULICS, LTD.
ELLIOTT NUCLEONICS, LTD.
ENGLISH ELECTRIC CO., LTD.
FAIREY CO., LTD., THE.
Control rod mechanisms.
HAWKER SIDDELEY NUCLEAR POWER CO. LTD.

339 CONTROL ROD DRIVES (contd.)

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS, LTD.
V.L.F. drives and controls.
LAURENCE SCOTT AND ELECTROMOTORS, LTD.
Variable speed electric motor drives.
MUIRHEAD AND CO., LTD.
Synchros for remote indication and control.
PALATINE (SURBITON), LTD.
PEEBLES, BRUCE, AND CO., LTD., Electronics division.
Static generation of L.F. power.
TELEFLEX PRODUCTS, LTD.

340 COOLERS

Q.V.F., LTD.
BATES BROS. (ENGINEERS), LTD.
CARRIER ENGINEERING CO., LTD.
Air, water.
CASTON BARBER, LTD.
DAVENPORT ENGINEERING CO., LTD.
Water.
DAVIDSON AND CO., LTD.
ENGLISH ELECTRIC CO., LTD., THE.
FAIREY CO., LTD., THE.
FIRTH BLAKELEY SONS AND CO., LTD.
LACY-HULBERT AND CO., LTD.
After-coolers.
LIGHTFOOT REFRIGERATION CO., LTD., THE.
Water, packaged.
MARSTON EXCELSIOR, LTD.
Gas and liquid.
NORTON AND RIDING (YORKS), LTD.
Lead coils and coolers.
PARKER MITCHELL ENG. CO., LTD.
Coolers (granular materials).
PREMIER COOLER AND ENG. CO., LTD., THE.
SERCK RADIATORS, LTD.
Air, gas, oil, water.
SHANDON SCIENTIFIC CO., LTD.
Laboratory cooling unit.
SPIRAL TUBE AND COMPONENTS CO., LTD., THE.
Oil, water, compressed air.
SPIRO-GILLS, LTD.
SUPERHEATER CO., LTD., THE.
Air.
THERMO ENGINEERS, LTD.
VISCO ENGINEERING CO., LTD., THE.
Water.

341 COOLING TOWERS

Q.V.F., LTD.
AIRSCREW CO. AND JICWOOD, LTD., THE.
Cooling tower fans.
BROTHERHOOD, PETER, LTD.
DAVENPORT ENGINEERING CO., LTD.
ENGLISH ELECTRIC CO., LTD., THE.
FILM COOLING TOWERS (1925), LTD.
FOSTER WHEELER, LTD.
HEAD WRIGHTSON PROCESSES, LTD.
MIDLAND HEATING AND VENTILATING CO., LTD., THE.
MITCHELL CONSTRUCTION CO., LTD., THE.
PEABODY, LTD.
Air and gas cooling towers.
RESISTANT EQUIPMENT, LTD.
P.v.c. fume absorption.
VISCO ENGINEERING CO., LTD., THE.
WRIGHTS FORGE AND ENG. CO., LTD.

342 CORE COMPONENTS

T.I. NUCLEAR ENGINEERING, LTD.
Fuel element supports; core restraint.
BORAX AND CHEMICALS, LTD.
Yttrium and Thorium Oxides, metals.
ENGLISH ELECTRIC CO., LTD., THE.
FAIREY CO., LTD., THE.
Graphite machining, restraint links, core-seal, fuel element channel fittings, Wigner growth micrometers.
HALL, MATTHEW, AND CO., LTD.
NEWBURGH ENGINEERING CO., LTD.
PLESSEY CO., LTD.
Dust iron cores, sleeves and yokes.
ROCOL, LTD.
Core locking compounds.
SHELL CHEMICAL CO., LTD.

343 CORROSION PROTECTION

B.B. CHEMICAL CO., LTD.
"Bostik Endurion" process.
B.K.L. ALLOYS, LTD.
Magnesium, zinc and aluminium anodes.
C. AND P. DEVELOPMENT CO. (LONDON), LTD.
Rust-Anode, cold galvanizing Capalla, Skaline.
ALBRIGHT AND WILSON (MFG.), LTD.
"Kanigen" chemical nickel plate.
ALLWEATHER PAINTS, LTD.
Special coatings.
ANDRE RUBBER CO., LTD.
BERK, F. W., AND CO., LTD.
BITULAC, LTD.
Paints.
BRISTOL METAL SPRAYING AND WELDING CO., LTD.
Sprayed metal coatings.
BRITISH PAINTS, LTD.
Strippable paint.
CHEMICAL BUILDING PRODUCTS, LTD.
Protective coatings; anti-corrosive paints.
CHEMICAL ENGINEERING CONSTRUCTION (PENSNETT), LTD.
CHROME-ALLOYING CO., LTD., THE.
Chromizing to resist corrosion, wear, oxidation.
DELORO STELLITE, LTD.
Cobalt-chromium-tungsten "Stellite" alloys.
DETEL PRODUCTS, LTD.
"Atomicote" chlorinated rubber paint, zinc primer.
DUNLOP RUBBER CO., LTD.
Linings, cements and treatments.
EDWARDS HIGH VACUUM, LTD.
Vacuum coating.
ENGLAND, HUGHES, BELL AND CO., LTD.
EVODE, LTD.
Bituminous, aluminium, epoxy, resin, paints.
FESCOL, LTD.
Electro-deposition, heavy nickel, hard chromium.
FIBRECLAD, LTD.
Plastic linings, on-site service.
FIBREGLASS, LTD.
Reinforced and plain tissue coating reinforcement.
FOWLER, H. G., AND CO., LTD.
Lining or covering with lead or p.v.c.
GARTHWOOD CO., LTD.
Metal protectives, hot-dip, cold (strippable).
GERALD GILMER, LTD.
HARPER, JOHN, AND CO., LTD.
Enamelling, plating, painting.
HAWKER SIDDELEY JOHN BROWN NUCLEAR CONSTRUCTION, LTD.
INDUSTRIAL PAINTING (WINCHESTER), LTD.
P.v.c., plastic spraying.
JABLO PLASTICS INDUSTRIES, LTD.
LEIGH, W. AND J., LTD.
Specialized paint products.
LEYLAND PAINT AND VARNISH CO., LTD.
MARSTON EXCELSIOR, LTD.
Tantalum, titanium and zirconium fabrications.
METAL AND PIPELINE ENDURANCE, LTD.
Cathodic protection services.
METAL DEPOSITS, LTD.
Metal spraying, painting, on site, own works.
METAL DIFFUSIONS, LTD.
Diffusion of metals.
METALLISATION, LTD.
Metal, plastic spraying equipment.
METAL SPRAYERS, LTD.
Metal protective coatings.
MURRAY AND RAMSDEN, LTD.
NASH AND THOMPSON, LTD.
Corrosion soil resistance meter.
NORTH BRITISH CHEMICAL CO., LTD.
NORTON GRINDING WHEEL CO., LTD.
Oxide coatings for metals, graphite.
PERDECK SOLDER PRODUCTS, LTD.
Solder paints.
PINCHIN JOHNSON AND CO.
Metallic, bituminous paints.
PLASTIC SHEATHING CO., THE.
Plastic linings, on-site application.
PRODORITE, LTD.
Acid-proofing.
PROTECTIVE RUBBER COATINGS (BRISTOL), LTD.
Synthetic rubber and silicone rubber, liquid applied.
RUSTLESS IRON CO., LTD.
ST. HELENS CABLE AND RUBBER CO., LTD.
Linings, natural rubber, synthetics and plastics.
SHELL CHEMICAL CO., LTD.
TANKS AND LININGS, LTD.
Coatings, acid resisting.
TELEDICTOR, LTD.
Crack detectors.
TELEGRAPH CONDENSER CO., LTD., THE.
TOOLCHROME, LTD.
TRETOL, LTD.
Paints, plastics, coatings; strippable.
UNIVERSAL METAL SPRAYERS, LTD.
WAILES, DOVE BITUMASTICS, LTD.
YORKSHIRE METAL SPRAYERS, LTD.

344 COUPLINGS

B.E.N. PATENTS, LTD.
"Instantair" quick action.
I.V. PRESSURE CONTROLLERS, LTD.
N.G.N. ELECTRICAL, LTD.
Solderless vacuum couplings.
ACCLES AND POLLOCK, LTD.
AIRTECH, LTD.
ATLAS COPCO (GREAT BRITAIN), LTD.
Pipe couplings, air.
AVICA EQUIPMENT, LTD.
For rigid tubes. Without welding or brazing.
BIRFIELD INDUSTRIES, LTD.
Universal joints.
BOWDEN (ENGINEERS), LTD.
Swaged and detachable for hydraulic and pneumatic hose.
BLOCTUBE CONTROLS, LTD.
BRITISH ERMETO CORPORATION, LTD.
High pressure pipe couplings in mild steel, stainless steel and brass.
BROWN, DAVID, CORPORATION (SALES), LTD., THE.
Flexible, gear-type.
CLAY CROSS (IRON AND FOUNDRIES), LTD.
CLAYTON-WRIGHT, HOWARD, LTD.
Clayflex.
CROFTS (ENGINEERS), LTD.
Flexible and hydraulic.
DICK, R. AND J., LTD.
DIXON-BATE, B., LTD.
Vacuum.
DRAYTON REGULATOR AND INSTRUMENT CO., LTD.
Bellows.
DURAPIPE AND FITTINGS, LTD.
Pipe; plastic/steel.
ELECTRO DYNAMIC CONSTRUCTION CO., LTD.
Magnetic.
EVA BROS., LTD.
Hammer forgings.
EXACTOR, LTD.
Self-sealing, for pipe dias. to 12 in.
FLIGHT REFUELLING, LTD.
Hot gas quick-release, self-sealing and clear bore.
GEARTIGHT UNIONS, LTD.
GUEST, KEEN AND NETTLEFOLDS (MIDLANDS), LTD.
Threaded fasteners.
GUYSON INDUSTRIAL EQUIPMENT, LTD.
HANCOCK AND CO. (ENGINEERS), LTD.
HATHAWAY, L., LTD.
HIGH PRESSURE COMPONENTS, LTD.
HOWARD MECHANICAL DEVELOPMENTS, LTD.
KINGS LANGLEY ENGINEERING CO., LTD.
"Kingley" copper tube couplings.
LAYCOCK ENGINEERING, LTD.
"Layrub" flexible couplings.
MACDONALD, JOHN, AND CO. (PNEUMATIC TOOLS), LTD.
"Macdonald" quick-action hose.
MANN, ALBERT ENGINEERING CO., LTD.
Universal type heavy torque.
METADUCTS, LTD.
Flexible power transmission.
METALASTIK, LTD.
Flexible.
MOLLART ENGINEERING CO., LTD., THE.
Universal joints; drive shafts.
OIL FEED ENGINEERING CO., LTD.
Self-sealing, special hiflex self-fitted, reusable.
PNEUMATIC COMPONENTS, LTD.
Air line couplings in three sizes.
POWER AUXILIARIES, LTD.
RENOLD CHAINS, LTD.
Complete range of couplings up to 1,500 h.p.
SILENTBLOC, LTD.
Flexible.
SIMPLIFIX COUPLINGS, LTD.
Compression.
SPEMBLY, LTD.
Low pressure self-sealing.
STEELE AND COWLISHAW, LTD.
STERLING METALS, LTD.
Cast hydraulic couplings in aluminium.
STEWARTS AND LLOYDS, LTD.
TALBOT STEAD TUBE CO., LTD.
Tube fittings.
TWIFLEX COUPLINGS, LTD.
Articulated, Flexilink and Rectiflex.
UNITED FLEXIBLE METALLIC TUBING CO., LTD., THE.
VICTAULIC CO., LTD., THE.
Flexible joints for steel, cast iron, concrete, asbestos cement and aluminium pipes.
WADE COUPLINGS, LTD.
Pipe compression type, metal, plastic.
WALKER, C. AND W., LTD.
Pipe.
WEST'S GAS IMPROVEMENT CO., LTD.
Electrically-operated shield.
WIGGLESWORTH, FRANK, AND CO., LTD.
Flexible, couplings.
WILSON PIPE FITTINGS, LTD.

345 CRANES

K. AND L. STEELFOUNDERS AND ENGINEERS, LTD.
ADAMSON, JOSEPH, AND CO., LTD.
ANDREWS AND PLATT (ENGINEERS), LTD.
ARROL, SIR WILLIAM, AND CO., LTD.
Cranes.
BABCOCK AND WILCOX, LTD.
BARNSLEY, JOHN, AND SONS, LTD.
Overhead travelling.
BRITISH ELECTRICAL REPAIRS, LTD.
BRITISH INDUSTRIAL ENGINEERING CO. LTD.
Travelling, revolving, overhead, Goliath.
BROOKHIRST IGRANIC, LTD.
Control systems.
BUTTER BROS. AND CO., LTD.
BUTTERLEY CO., LTD., THE.
Electric overhead travelling.
CARRUTHERS, J. H., AND CO., LTD.
CLARKE, CHAPMAN AND CO., LTD.
CLYDE CRANE AND BOOTH, LTD.

345 CRANES (contd.)

COWANS, SHELDONS AND CO., LTD.
Overhead, jib, Goliath, turntable.
ENTWISLE AND GASS, LTD.
EPCO, LTD.
Hydraulic cranes.
FELCO HOISTS, LTD.
HENDERSON, JOHN M., AND CO., LTD.
HEYWOOD, S. H., AND CO., LTD.
Overhead; traversers, transporters.
IRVING ENGINEERING CO., LTD.
Overhead, travelling, conveyors, elevators.
KING, G. W., LTD.
Overhead electric travelling cranes, overhead manually-operated cranes.
LAMBERT ENGINEERING CO. (GLASGOW), LTD.
LEES, HENRY, AND CO., LTD.
MATTERSON, LTD.
Overhead, travelling.
MIDLAND INDUSTRIES, LTD.
Conversion to oil firing.
MOFFAT ENGINEERING CO., LTD.
MORRIS, HERBERT, LTD.
Hand and electric overhead cranes, mobile cranes
PARKER MITCHELL ENG. CO., LTD.
Cranes up to 5 tons capacity.
PATERSON HUGHES ENGINEERING CO., LTD.
Electric, overhead, travelling.
RANSOMES AND RAPIER, LTD.
Mobile.
REED CRANE AND HOIST CO., LTD.
RICHARDSON, R. J., AND SONS, LTD. (A).
SMITH, JOHN (KEIGHLEY), LTD.
All types of overhead and Goliath cranes.
STEELS ENGINEERING PRODUCTS, LTD.
"Coles" self-propelled, truck-mounted, 5 to 50 tons.
STOTHERT AND PITT, LTD.
All types.
TEES SIDE BRIDGE AND ENGINEERING WORKS, LTD.
Cranes, Goliath.
VAUGHAN CRANE CO., LTD.
WARD, THOS. W., LTD.
WHARTON CRANE AND HOIST CO., LTD., THE.
Overhead, electric, travelling, hand.
WICKHAM ENGINEERING CO., LTD.
WILD, THOS. C., (MACHINERY), LTD.
Tower, electric, rail-mounted, overhead.

346 CRUSHING AND GRINDING PLANT

APEX CONSTRUCTION, LTD.
Comminuting, cutter, vibratory and barrel mills.
CLARKE, CHAPMAN AND CO., LTD.
Quarry stone, ore, gravel, coal, etc.
CRAVENS, LTD.
DUNDEE CONTRACTING CO., LTD.
Bottoming, whinstone aggregate.
FOLLSAIN-WYCLIFFE FOUNDRIES, LTD.
Liner plates, etc., in C.Y. abrasion resisting alloy.
HADFIELDS, LTD.
MANSFIELD, FRANK, AND CO., LTD.
Pulverisors.
MORITZ CHEMICAL ENGINEERING CO., LTD.
Grinding mill, hammer mill, turbo-colloid mill.
PASCALL ENGINEERING CO., LTD., THE.
ROYAL WORCESTER INDUSTRIAL CERAMICS, LTD.
Grinding media (ceramic).
SHEEPBRIDGE EQUIPMENT, LTD.
Gyratory, jaw, roller crushers, rod ball mills.
SIMON-CARVES, LTD.
STEELE AND COWLISHAW, LTD.
VICKERS-ARMSTRONGS (ENGINEERS), LTD.
WAKES AND LAMB.

347 CYCLONES

AIR CONTROL INSTALLATIONS, LTD.
Dry.
BATES BROS. (ENGINEERS), LTD.
BUELL (1952), LTD.
High efficiency, all kinds of materials.
CONTROLLED HEAT AND AIR, LTD.
FAIRLEEDE ENGINEERING, LTD.
GRIFFITHS, A. E., (SMETHWICK), LTD.
HOLMES, W. C., AND CO., LTD.
JOHNSTONE, ARCHIBALD, (ENGINEERS), LTD.
Dry.
MANCUNA ENGINEERING, LTD.
MATTHEWS AND YATES, LTD.
Dry.
MOFFAT ENGINEERING CO., LTD.
POWER-GAS CORPORATION, LTD.
RICHARDSON, R. J., AND SONS, LTD.
RICHARDSON, W., AND CO., LTD.
SIMON-CARVES, LTD.
Dry.
SPENCER AND HALSTEAD, LTD.
STANDARD AND POCHIN BROS., LTD., THE.
THERMIX INDUSTRIES, LTD.
Complete schemes for dust control, recovery.
VICKERYS, LTD.
Hydro type, corrosion and abrasion-resisting.
WALKER, P. M., AND CO. (HALIFAX), LTD.
All forms of dust collection.
WEST LONDON IRON AND WIRE WORKS, LTD.
Cyclones.
WRIGHTS FORGE AND ENG. CO., LTD.

348 DATA HANDLING EQUIPMENT

IEC-SIEGER, LTD.
RCA GREAT BRITAIN, LTD.
Complete transistorised electronic data processing system.
ARCHIMEDES DIEHL MACHINE CO., LTD.
Diehl desk calculators.
ARMSTRONG-WHITWORTH EQUIPMENT.
Analogue/digital and digital/analogue converters. Time and frequency measuring.
ASSOCIATED ELECTRICAL INDUSTRIES, LTD.
Instrumentation division.
ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY), LTD., Electronic Apparatus division.
BAILEY METERS AND CONTROLS, LTD.
CAMBRIDGE INSTRUMENT CO., LTD.
Chart analyser.
ELLIOTT NUCLEONICS, LTD.
ENGLISH ELECTRIC CO., LTD., THE.
ERICSSON TELEPHONES, LTD.
Analogue-digital converters, data recording systems.
HONEYWELL CONTROLS, LTD.
KELVIN AND HUGHES (INDUSTRIAL), LTD.
LAMSON ENGINEERING CO., LTD.
Document conveying systems.
LANCASHIRE DYNAMO ELECTRONIC PRODUCTS, LTD.
Digit check, indicate, record, tabulate and summate.
LINTRONIC, LTD.
Multiplexer and decoding matrix.
MULLARD EQUIPMENT, LTD.
PEEBLES, BRUCE, AND CO., LTD. Electronics division.
PLESSEY CO., LTD.
RACAL INSTRUMENTS, LTD.
Translators, serialisers, in-line readout printout.
SALFORD ELECTRICAL INSTRUMENTS, LTD.
SANDERS, W. H. (ELECTRONICS), LTD.
SPERRY GYROSCOPE CO., LTD.
Data transmission elements magnetic storage devices.
TELECOMMUNICATION INSTRUMENTS, LTD.
WINSTON ELECTRONICS, LTD.

349 DEMINERALIZATION PLANT

BOBY, WILLIAM, AND CO., LTD.
ELGA PRODUCTS, LTD.
Elgastat Deionisers.
HEAD WRIGHTSON PROCESSES, LTD.
MAXIM SILENCERS, LTD.
Water distillation apparatus.
MONKS AND CRANE, LTD.
PATERSON ENGINEERING CO., LTD., THE.
Ion exchange.
PERMUTIT CO., LTD., THE.

350 DOORS

ARMSTRONG PATENTS CO., LTD.
Strongarm closers.
BARKER, JOHN, AND SON (ENGINEERS), LTD.
BATES BROS. (ENGINEERS), LTD.
Patent folding doors for interior and exterior.
BOLTON GATE CO., LTD., THE.
BRADY, G., AND CO., LTD.
Rolling, sliding shutter, fireproof.
CASTON BARBER, LTD.
COBURN ENGINEERS, LTD.
Sliding and folding gear.
CURFEW DOORS AND SHUTTERS, LTD.
Fireproof, steel, rolling, collapsible.
DUNLOP RUBBER CO., LTD.
Rubber-panelled.
FOX, F., LTD.
HALL ENGINEERING, LTD.
HAYWARDS, LTD.
Steel, fire resisting steel doors, sliding or hinged.
KING, G. W., LTD.
Sliding doors, soundproof, radiation proof, etc.
MALLINSON, WILLIAM, AND SONS, LTD.
Armourply metal faced doors.
MORTON, FRANCIS, AND CO., LTD.
Doors.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Protection against radiation.
THOMPSON-KENNICOTT, JOHN, LTD.
THORNBOROUGH AND SON (MANCHESTER), LTD.
Sliding, fireproof; roller shutters, collapsible.
WALKER, C. AND W., LTD.
Heavy shielding.
WESTWOOD, JOSEPH, AND CO., LTD.
Solid steel.

351 DRIVES

M.T.E. CONTROL GEAR, LTD.
Variable speed.
ARENS CONTROLS, LTD.
Remote; push, pull, transmission.
ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY), LTD., (Motor and Control Gear Division).
Electric motors and control.
BIRFIELD INDUSTRIES, LTD.
Drive shafts and universal joints.
BRITISH ELECTRICAL REPAIRS, LTD.
Ward Leonard sets to 10 kW.
BROWN, DAVID, CORPORATION (SALES), LTD., THE.
All types of gear drive.
CROFTS (ENGINEERS), LTD.
Variable speed, reduction gears.
CROMPTON PARKINSON, LTD.
Electric motors, and associated controls.
DICK, R. AND J., LTD.
ELECTRICAL POWER ENGINEERING CO. (B'HAM), LTD.
Ward Leonard sets.
ENTWISLE AND GASS, LTD.
ENGLISH ELECTRIC CO., LTD., THE.
FLUIDRIVE ENGINEERING CO., LTD.
Vulcan-Sinclair variable speed fluid couplings.
GLOBE PNEUMATIC ENG. CO., LTD., THE.
Radial type air motors.
LANCASHIRE DYNAMO ELECTRONIC PRODUCTS, LTD.
Single and multi motor, vari-speed, torque.
LANCASHIRE DYNAMO NEVELIN, LTD.
Variable speed.
MANN, ALBERT ENGINEERING CO., LTD.
Ward Leonard electric control.
METADUCTS, LTD.
Power transmission couplings.
MORRIS, B. O., LTD.
NELSON ENGINEERING CO., LTD., THE.
Variable speed.
PEEBLES, BRUCE AND CO., LTD.
Electronics division.
RENOLD CHAINS, LTD.
Transmission and conveying chains.
SAUTER CONTROLS, LTD.
Electric, pneumatic.
VACUUM RESEARCH (CAMBRIDGE), LTD.
¼–2 h.p. variable speed hydraulic transmission.
VICKERS-ARMSTRONGS (ENGINEERS), LTD.
WESTOOL, LTD.
WIGGLESWORTH, FRANK, AND CO., LTD.

352 DRYING PLANT

A.E.I.-BIRLEC, LTD.
Instrument, hydrogen, compressed air, CO_2.
ANDREW AIR CONDITIONING, LTD.
Humidifying, de-humidifying.
APEX CONSTRUCTION, LTD.
Air tray, truck conveyor, vacuum tray and rotary.
BARLOW-WHITNEY, LTD.
BATES BROS. (ENGINEERS), LTD.
BRITISH COMPRESSED AIR SOCIETY.
BUELL (1952), LTD.
Rotary, turbo tray, spray; complete plants.
BURNETT AND LEWIS, LTD.
Air and process gases.
CALMIC ENGINEERING CO., LTD.
Vacuum, stainless steel for beryllium, zirconium.
CARRIER ENGINEERING CO., LTD.
Conveyorized drying ovens.
DENCO MILLER, LTD.
Drying plant, de-humidification plant for S.R.U. and reactor erection.
GRIFFITHS, A. E. (SMETHWICK), LTD.
Tanks for all industrial processes, storage, etc.
HOLMES, W. C., AND CO., LTD.
Air and other gases.
INCANDESCENT HEAT CO., LTD., THE.
Plant for drying gases using activated alumina, silica gel, and molecular sieves.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
Stain-free drying of metal using "Trisec."
MITCHELL, L. A., LTD.
PARKER MITCHELL ENG., CO., LTD.
Granular materials e.g. wet sand.
PORTER, ALFRED (SALES), LTD.
"Himiditrol" absorption equipment.
SALFORD ELECTRICAL INSTRUMENTS, LTD.
Gas scrubbers and driers (fission product detection).
SILICA GEL, LTD.
Gas dryers, compressed air dryers.
SIMON, RICHARD AND SONS, LTD.
TOMLINSONS (ROCHDALE), LTD.
"Drydapta" machines.
VICKERS-ARMSTRONGS (ENGINEERS), LTD.
VICKERYS, LTD.
Centrifugal.
WEATHERFOIL, LTD.
Air.
WILSON, EDWARD AND SON, LTD.
Cabinet and conveyor dryers.

353 DUCTING

A.C.M. ELECTRONICS, LTD.
ACALOR (1948), LTD.

353 DUCTING (contd.)

AIR CONTROL INSTALLATIONS, LTD.
AITON AND CO., LTD.
ALLEN, ALFRED, AND SON, LTD.
ALLEN, W. G., AND SON (TIPTON), LTD.
BABCOCK AND WILCOX, LTD.
BATES BROS. (ENGINEERS), LTD.
BEAKBANE, HENRY (FORTOX), LTD.
Flexible plastic fabricated.
BERRY, Z. D., AND SONS, LTD.
In all metals and plastics.
BIRWELCO, LTD.
BROADS MANUFACTURING CO., LTD.
"Trucast", Stelduct duct, access covers, frames.
BROWN, E. G., AND CO., LTD.
Metal ducting made to specification.
BURNLEY AIRCRAFT PRODUCTS, LTD.
Aluminium, sheet steel.
CARRIER ENGINEERING CO., LTD.
Spiral air conduit and fittings.
CASTON BARBER, LTD.
CHEMIDUS PLASTICS, LTD.
DAVIDSON AND CO., LTD.
Metallic.
EXTRUDEX, LTD.
FAIRLEEDE ENGINEERING, LTD.
FARMER BROS. (SHIFNAL), LTD.
EDWARD FARR, LTD.
FIBRECLAD, LTD.
Reinforced plastic.
FIBREGLASS, LTD.
Insulation.
FLEXIBLE DUCTING, LTD.
FOWLER, H. G., AND CO., LTD.
Fabrication from lead or p.v.c.
GARDNER, J., AND CO., LTD.
GRIFFITHS, A. E. (SMETHWICK), LTD.
Glass fibre reinforced plastic-fabrications.
HALL BROS. (NETHERTON), LTD.
JENKINS, ROBERT, AND CO., LTD.
M.s.; CO_2.
JENKINSON, W. G., LTD.
S.s. alum. plastic.
JOHNSTONE, ARCHIBALD, (ENGINEERS), LTD.
LONGCLOSE ENGINEERING CO., LTD., THE.
S.s.
MAITLANDS (METAL WORKS), LTD.
MANCUNA ENGINEERING, LTD.
MOFFAT ENGINEERING CO., LTD.
MOORE, W. AND E., LTD.
MORTON, FRANCIS, AND CO., LTD.
Ducting.
MORTON MACHINE CO., LTD.
MOTHERWELL BRIDGE AND ENGINEERING CO., LTD., THE.
Lloyd's, class I other specifications.
NEILL, WM., AND SON (ST. HELENS), LTD.
Chimneys, large diameter piping.
PARSONS, C. A., AND CO., LTD.
PEARSON, T. B., AND SONS (ENGINEERS), LTD.
PIPE FABRICATORS (STAMFORD), LTD.
PLESSEY CO., LTD.
Plessiflex flexible metallic ducting.
REDHEUGH IRON AND STEEL CO. (1936), LTD.
REDHEUGH-WILLEY, LTD.
Gas and air ducting for boilers.
RESISTANT EQUIPMENT, LTD.
Corrosion resisting p.v.c.
RICHARDSON, W., AND CO., LTD.
SHEEPBRIDGE EQUIPMENT, LTD.
Complete installations.
SIMON-CARVES, LTD.
SPENCER AND HALSTEAD, LTD.
STAINLESS STEEL PROFILE CUTTERS, LTD.
STIRLING, R. B., AND CO., LTD.
TANKS AND LININGS, LTD.
Acid resisting plastic.
THOMPSON, JOHN, LTD.
TUPHOLME, GEORGE E., AND CO., LTD.
Ventilation; air; dampers.
UNISTRUT DIVISION OF SANKEY SHELDON, LTD.
Pipe supports.
UNIVERSAL BOILERS AND ENGINEERING CO., LTD.
Aluminium, sheet steel.
VICKERS-ARMSTRONGS (SHIPBUILDERS), LTD.
VISCO ENGINEERING CO., LTD., THE.
WEST LONDON IRON AND WIRE WORKS, LTD.
Ducting, hoods, cupboards, etc.
WESTWOOD, JOSEPH, AND CO., LTD.
WRIGHTS FORGE AND ENG. CO., LTD.
X-LON PRODUCTS, LTD.
Plastics.
YARROW AND CO., LTD.
YORKSHIRE ENGINEERING AND WELDING CO. (BRADFORD), LTD.

354 DUST REMOVAL

ACME VENTILATING, LTD.
AIR CONTROL INSTALLATIONS, LTD.
AMBUCO, LTD.
ANDREW AIR CONDITIONING, LTD.
BATES BROS. (ENGINEERS), LTD.
BIRFIELD INDUSTRIES, LTD.
BUELL (1952), LTD.
High efficiency complete; wet de-dusters; discharge valves.
CONTROLLED HEAT AND AIR, LTD.
Wet and dry collectors.
DALLOW LAMBERT AND CO., LTD.
DUSTRACTION, LTD.
Pneumatic conveyors.
GRIFFITHS, A. E. (SMETHWICK), LTD.
Corrosion resistant exhaust systems in p.v.c.
GUYSON INDUSTRIAL EQUIPMENT, LTD.
HOLMAN BROS., LTD.
Dustractor low volume high velocity system.
HOLMES, W. C., AND CO., LTD.
Collection and control plant.
HOWDEN, JAMES, AND CO., LTD.
Mechanical and electro precipitators.
INTERNATIONAL ENGINEERING CONCESSIONAIRES, LTD.
IRWIN, E. G., AND PARTNERS, LTD.
Design installation of complete systems.
KEITH BLACKMAN, LTD.
MAITLANDS (METAL WORKS), LTD.
MANCUNA ENGINEERING, LTD.
MATTHEWS AND YATES, LTD.
Dry installations.
METALLIZING EQUIPMENT CO., LTD.
Dust removal, dry and water wash.
MIDLAND HEATING AND VENTILATING CO., LTD., THE.
NEW WELBECK, LTD.
Portable suction cleaners.
PEABODY, LTD.
Air and gas scrubbing equipment.
PULVERISING MACHINERY, LTD.
RICHARDSON, R. J., AND SONS, LTD.
SIMON-CARVES, LTD.
SPENCER AND HALSTEAD, LTD.
STEELS ENGINEERING INSTALLATIONS, LTD.
Dry centrifugal dust collectors.
STURTEVANT ENGINEERING CO., LTD.
Units, portable.
SUPERVENTS, LTD.
THERMIX INDUSTRIES, LTD.
Complete schemes for dust control.
THOMPSON, JOHN, LTD.
VISCO ENGINEERING CO., LTD., THE.
WALKER, P. M., AND CO. (HALIFAX), LTD.
And collection.
WEATHERFOIL, LTD.
WEST LONDON IRON AND WIRE WORKS, LTD.
Dust removal, ventilation, etc.

355 EFFLUENT TREATMENT

AITON AND CO., LTD.
Plant for concentration purposes.
ALLEN, EDGAR, AND CO., LTD.
Crushing equipment.
BOBY, WILLIAM, AND CO., LTD.
CANDY FILTER CO., LTD., THE.
CAMBRIDGE INSTRUMENT CO., LTD.
pH or conductivity control.
CHEMICAL ENGINEERING CONSTRUCTION (PENSNETT), LTD.
EKCO ELECTRONICS, LTD.
Monitors.
FRASER, W. J., AND CO., LTD.
Radio-active and other effluents.
FULLERS' EARTH UNION, LTD., THE.
Cation-exchanging clays.
GENERAL DESCALING CO., LTD.
Drains cleaning equipment and service.
HEAD WRIGHTSON PROCESSES, LTD.
HOLMES, W. C., AND CO., LTD.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
"Alfloc" water treatment service.
INCANDESCENT HEAT CO., LTD., THE.
LENNIG, CHARLES, LTD.
LOCK, A. M., AND CO., LTD.
pH controllers and automatic detoxication of cyanide and chromate wastes.
MAITLANDS (METAL WORKS), LTD.
MANDOVAL, LTD.
Vermiculite.
MENDIP (CHEMICAL ENGINEERING), LTD.
Tanks and piping in reinforced resin.
MOFFAT ENGINEERING CO., LTD.
MOORE'S (WALLISDOWN), LTD.
Active waste, sorting cabinets.
MUNRO, R. W., LTD.
PATERSON ENGINEERING CO., LTD., THE.
General plant.
PEABODY, LTD.
Gaseous.
PERMUTIT CO., LTD., THE.
Ion exchange plant.
PHILIPS ELECTRICAL, LTD.
PLESSEY NUCLEONICS, LTD.
Effluent monitoring equipment.
PRODORITE, LTD.
Drainage schemes.
PYE, W. G., AND CO., LTD.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Liquid clarification.
SHARPLES CENTRIFUGES, LTD.
SIMON-CARVES, LTD.
STOCKDALE ENGINEERING, LTD.
Liquid treatment, clarification, solids disposal.
THOMPSON, JOHN, LTD.
THOMPSON-KENNICOTT, JOHN, LTD.
Trade, active waste.
TRIST, RONALD, AND CO., LTD.
Mobrey magnetic level switches.
VICKERYS, LTD.
Centrifugal filters.

356 ELECTRICAL ELECTRONIC COMPS.

A.E.W., LTD.
A.N.T.E.X., LTD.
Miniature soldering irons.
A.P.T. ELECTRONIC INDUSTRIES, LTD.
Power supplies transformers, toroidal winding; wirewound resisters.
B. AND R. RELAYS, LTD.
Relays and control gear; timing units.
C. AND N. (ELECTRICAL), LTD.
C.N.S. INSTRUMENTS, LTD.
A.C. mains stabilizer.
C.W.C. EQUIPMENT, LTD.
Connectors, wiring systems.
D.S. PLUGS, LTD.
IBM UNITED KINGDOM, LTD.
Timing systems, programme and relay cabinets.
K.D.G. INSTRUMENTS, LTD.
Transducers.
M.B. METALS, LTD.
Terminations, connectors, butting connectors, pressure switches, push-push switches, instrument lighting.
M-O VALVE CO., LTD., THE.
N.S.F., LTD.
Switches, printed circuits, connectors, potentiometers, miniature relays.
P.A.M., LTD.
P. AND B. ENGINEERING CO., LTD.
Relays; starting, overload, stalling.
RCA GREAT BRITAIN, LTD.
Complete range of receiving tubes, cinescopes, transistors and industrial tubes (e.g., photomultiplier tubes, vidicons and power tubes).
ABLE ENGINEERING CO., LTD.
ACRU ELECTRIC TOOL MFG. CO.
ADCOLA PRODUCTS, LTD.
Soldering equipment.
ADVANCE COMPONENTS, LTD.
Constant voltage transformers, attenuators.
AMPLIVOX, LTD.
Headphone, headsets, earphone, microphones and communication systems.
ANDEC, LTD.
ANTICOUSTIC CO., LTD.
ARMSTRONG WHITWORTH EQUIPMENT.
High-speed sampling switches, directional couplers, U.H.F. oscillator, calibration units.
ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY), LTD.
Power rectifiers.
ATKINS, ROBERTSON AND WHITEFORD, LTD.
Transformers, pulse-forming networks, delay lines.
AUSTIN TAYLOR ELECTRICAL, LTD.
Terminals, cable glands.
AVELEY ELECTRIC, LTD.
Toroidally-wound transformers, transductors, inductors, reactors, filters.
BELCLERE CO., THE.
Subminiature, miniature and small transformers, chokes and windings.
BRAY, E. N., LTD.
BRITISH CENTRAL ELECTRICAL CO., LTD.
BRITISH INSULATED CALLENDER'S CABLES, LTD.
Capacitors.
BRITISH PHYSICAL LABORATORIES.
Meters, microamp, volt; hermetically sealed.
BROWNING'S ELECTRIC COMPANY, LTD.
Soldering irons, coil winding regulators actuators.
BRUSH CRYSTAL CO., LTD.
BRYCE ELECTRIC CONSTRUCTION CO., LTD.
Capacitors, transformers, reactors.
BULGIN, A. F., AND CO., LTD.
Connectors, holders, plugs, switches, etc.
CABLEFORM, LTD.
Contactor gear; cable assemblies.
COX-WALKERS, LTD.
Voltage regulators.
CRAIG AND DERRICOTT, LTD.
Indicator lamps, limit, rotary, mini- and push-button switches.
CRESSALL MANUFACTURING CO., LTD., THE.
Rheostats, potentiometers, auto-transformers.
CROMPTON PARKINSON, LTD.
Distribution plant, lighting, stud welding equipment.
DALY (CONDENSERS), LTD.
Electrolytic condensers.
DAVIS, JOHN, AND SONS (DERBY), LTD.
Relays, transformers, signalling, F.L.P. equipment.
DEPENDABLE RELAY CO., LTD.
Relays.
DEWHURST AND PARTNER, LTD.
Relays, contactors, starters, control panels.
DONOVAN ELECTRICAL CO., LTD., THE.
Relays, contactors, starters, control panels.
DORAN INSTRUMENT CO., LTD.
DUBILIER CONDENSER CO. (1925), LTD.
Capacitors, carbon, wire-wound resistors.
DUKES AND BRIGGS ENGINEERING CO., LTD.
ELECTRICAL REMOTE CONTROL CO., LTD.
Multiple contact and mercury relays.
ELECTRO DYNAMIC CONSTRUCTION CO., LTD.
Converters, regulators.
ELECTRONIC TUBES, LTD.
Industrial cathode ray tubes.
ELECTROTHERMAL ENGINEERING, LTD.

356 ELECTRICAL ELECTRONIC COMPS. (contd.)

ENGLISH NUMBERING MACHINES, LTD.
Precision counting devices.
ENGLISH ELECTRIC VALVE CO., LTD.
Conventional radio valves, microwave tubes.
ENGLISH ELECTRIC CO., LTD., THE.
EXPANDED METAL CO., LTD., THE.
Resistors, voltage stabilisers.
EXPRESS TRANSFORMERS AND CONTROLS, LTD.
FAIREY CO., LTD., THE.
Actuators, automatic soldering, looms, printed circuits, potted circuits.
FALK STADELMANN AND CO., LTD.
Vapour corrosion resistant lighting fittings cables, armoured cables.
FARNELL INSTRUMENTS, LTD.
FEEDBACK, LTD.
FIELDEN ELECTRONICS, LTD.
FORTIPHONE, LTD.
FOX, P. X., LTD.
Potentiometers.
FULLER ELECTRIC, LTD.
Transformers, tap changers.
FRASER, SPELLER TRANSFORMERS, LTD.
Transformers, chokes.
GARNERS RADIO, LTD.
Transformers and chokes.
GOODMANS INDUSTRIES, LTD.
Loudspeakers, transformers, vibration generators, power amplifiers, oscillators.
GRESHAM TRANSFORMERS, LTD.
Transformers, voltage regulators, electronics to custom requirements.
HACKBRIDGE AND HEWITTIC ELECTRIC CO., LTD.
HADLEY TELEPHONE AND SOUND SYSTEMS, LTD.
Amplifiers, panels, communication systems.
HAMBLING INDUSTRIES, LTD.
HARVEY ELECTRONICS, LTD.
Bulk erasers for magnetic tape, transformers.
HELLERMAN, LTD.
HENDREY RELAYS, LTD.
Rotary and special purpose switches.
HOLIDAY AND HEMMERDINGER, LTD. (A).
HORSTMANN GEAR CO., LTD., THE.
Time switches.
HUNT, A. H. (CAPACITORS), LTD.
Capacitors.
IEC-SIEGER, LTD.
ISENTHAL AND CO., LTD.
Automatic regulators, relays, rheostats.
JOBLING, JAMES A., AND CO., LTD.
JONES, J., AND CO. (NOTTINGHAM), LTD.
JOHNSON AND PHILLIPS, LTD.
Transformers, capacitors.
KINGSTON INSTRUMENT CO., LTD.
KLAXON, LTD.
Audible signals, alarms.
LANCASHIRE DYNAMO ELECTRONIC PRODUCTS, LTD.
Complete units for special applications.
LANGHAM THOMPSON, J., LTD.
Electronic components; transducers, recording cameras, voltage regulations, selerium rectifiers.
LONDEX, LTD.
Relays, timers.
MCGEOGH, WILLIAM, AND CO., LTD.
Plugs, sockets, multi-pin, bakelite, mouldings, light fittings, indicator fittings.
McMURDO INSTRUMENT CO., LTD., THE.
MAGNETIC DEVICES, LTD.
MAGNETIC AND ELECTRICAL ALLOYS, LTD.
Nickel and silicon laminations, magnetic shields.
MEGATRON, LTD.
Selenium photo cells.
MERITUS (BARNET), LTD.
Battesy chargers, rectifiers, transformers, impedance testers.
MINING AND CHEMICAL PRODUCTS, LTD.
Semi-conductors.
MORRIS, J., ELECTRICAL ENGINEERING CO., LTD.
MULLARD, LTD.
Electronic valves, tubes, semi-conductor devices.
NALDER BROS. AND THOMPSON, LTD.
Relays.
NELSON ENGINEERING CO., LTD., THE.
Transformers, rectifier equipment, regulators.
NELSON, W. AND H., LTD.
NEWMARKET TRANSISTORS, LTD.
Semi-conductor devices, transistors.
NEWPORT INSTRUMENTS (SCIENTIFIC AND MOBILE), LTD.
NEWTON BROS. (DERBY), LTD.
PAINTON AND CO., LTD.
Fixed, adjustable, wire-wound, carbon resistors; potentiometers.
PALMER, G. A. STANLEY, LTD.
PARSONS, C. A., AND CO., LTD.
PHILLIPS CONTROL (G.B.), LTD.
Solenoids AC and DC transformers.
PLESSEY CO., LTD.
Valveholders, suppressors, tantalum capacitors, thermistors, trimmers, diodes, infra-red detectors, etc.
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PULLIN, R. B., AND CO., LTD.
READ AND PARTNERS, LTD.
RECORD ELECTRICAL CO., LTD., THE.
"Cirscale" electrical measuring instruments and electric tachometers, protective relays.
REDCLIFFE RADIO AND ENGINEERING CO., LTD.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Transformers, stabilisers.
RIVLIN INSTRUMENTS, LTD.
ROBINSON, D., AND CO.
Relays, timers and transformers.
ROSS COURTNEY AND CO., LTD.
SANDERS, W. H. (ELECTRONICS), LTD.
SANGAMO WESTON, LTD.
Panel meters.
SAUTER CONTROLS, LTD.
Contactors, starters, relays.
SCOTT, HUGH J., AND CO. (BELFAST), LTD.
AC and DC motors, generators, etc.
SEMICONDUCTORS, LTD.
Transistors.
SERVOMEX CONTROLS, LTD.
SINEX ENGINEERING CO., LTD.
Vibratory tables, screens, conveyors, etc.
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SOLARTRON ELECTRONIC GROUP, LTD.
Analogue computing modules. Stabilised HT and LT power supplies.
SOUND INDUSTRIES.
SPEAR ENGINEERING CO., LTD.
SPERRY GYROSCOPE, CO., LTD.
Transformers, integrators, tachogenerators.
SOUTH WALES SWITCHGEAR, LTD.
STEWART AERONAUTICAL SUPPLY CO., LTD.
Wide range of accessories. (A)
STONEBRIDGE ELECTRICAL CO., LTD., THE.
STRATTON AND CO., LTD.
VHF/UHF equipment.
TAYLOR ELECTRICAL INSTRUMENTS, LTD.
Panel meters.
TECHNOGRAPH ELECTRONIC PRODUCTS, LTD.
Resistors, inductors, capacitors; strain gauges.
TELEDICTOR, LTD.
Transformers, chokes; sub-contract units.
TELEGRAPH CONDENSER CO., LTD., THE.
Capacitors.
TELEPHONE MANUFACTURING CO., LTD., THE.
Capacitors; electro-magnetic relays.
TEXAS INSTRUMENTS, LTD.
Semiconductors, transistors, rectifiers, zener diodes.
THORN ELECTRICAL INDUSTRIES, LTD.
TRANSFORMER AND ELECTRICAL CO., LTD. THE.
TYER AND CO., LTD.
Transformers; R.F., EHT units 8/12 kV.
ULTRASONOSCOPE CO. (LONDON), LTD.
UNISTRUT DIVISION OF SANKEY SHELDON, LTD.
Fluorescent trunking, supports for electrical services.
UNITED INSULATOR DIVISION OF T.C.C.
Electrical, electronic components, ultrasonic transducers, accelerometers, condensers, insulators, development.
VACTITE WIRE CO., LTD.
VITALITY BULBS, LTD.
Miniature, sub-miniature bulbs.
WELWYN ELECTRICAL LABORATORIES, LTD.
Wirewound, carbon, metal-oxide resistors; potentiometers, potentiometer panel-assemblies.
WESTOOL, LTD.
Transformers, coils, amplifiers.
WEYMOUTH RADIO MANUFACTURING CO., LTD.
Coils, transformers and delay lines.
WILFLO PRODUCTS, LTD.
Transformers, rectifiers.
WINDER, R. F., LTD.
WINGROVE AND ROGERS, LTD.
"Polar" radio and electronic components.
WINSTON ELECTRONICS, LTD.
YORKSHIRE ELECTRIC TRANSFORMER, LTD.
ZENITH ELECTRIC CO., LTD., THE.
"Variac" Zenith transformers, inductances, wire-wound resistors, rheostats, flash testing voltage regulators.

357 ELECTROSTATIC SEPARATORS

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HOLMES, W. C., AND CO., LTD.
Precipitators.
MILES-HIVOLT, LTD.
PELL, OLIVER CONTROL, LTD.
RAPID MAGNETIC, LTD.
SIMON-CARVES, LTD.
STURTEVANT ENGINEERING CO., LTD.
Precipitators.

358 ENGRAVING

C. AND N. (ELECTRICAL), LTD.
BUTLER RADIO MFG. CO. (ROCHESTER), LTD.
CAXTON NAMEPLATE MANUFACTURING CO., LTD.
ELECTROMARK (G.B.), LTD.
FYFE, WILSON AND CO., LTD.
GROVE METAL MANUFACTURING CO., LTD.
Instrument dial manufacturers.
MILLETT, LEVENS (ENGRAVERS), LTD.
PRECISION UNITS, LTD.
Labels, plates.
SEALEY ENGINEERING CO., LTD.
THREADWELL, J. J., AND SONS, LTD.

359 EXPANSION JOINTS

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"Bostiko" curtain wall sealants.
AITON AND CO., LTD.
ASHMORE, BENSON, PEASE AND CO., LTD.
AVICA EQUIPMENT, LTD.
Stainless steel for all types of movement.
BLUNDELL AND CROMPTON, LTD.
BRITISH APPLIANCES MFG. CO., LTD., THE.
Steel, s.s.
DENTON AND CO.
Synthetic and natural rubber.
DEWRANCE AND CO., LTD.
DUNLOP RUBBER CO., LTD.
ENGINEERING APPLIANCES, LTD.
I.W.K. compensators.
ENGLISH ELECTRIC CO., LTD., THE.
FAIRLEEDE ENGINEERING, LTD.
Fabricated mild steel and stainless steel.
FIRTH, BLAKELEY, SONS, AND CO., LTD.
HEINKE, C. E., RUBBER MANUFACTURERS, LTD.
JENKINS, ROBERT, AND CO., LTD.
JOHNSTONE, ARCHIBALD (ENGINEERS), LTD.
LUCAS, JOSEPH, LTD.
S.s., nimonic.
MICANITE AND INSULATORS CO., LTD., THE.
Durajoint—p.v.c. strip for all concrete structures.
MOFFAT ENGINEERING CO., LTD.
MUNRO AND MILLER, LTD.
"Bellex" expansion joints.
NORTH BRITISH RUBBER CO., LTD., THE.
POWER FLEXIBLE TUBING CO., LTD., THE.
SAMSON CONTROLS (LONDON), LTD.
Metal bellows.
TEDDINGTON AIRCRAFT CONTROLS, LTD.
S.s., inconel, monel, nimonic alloys, titanium.
TURNERS BROTHERS ASBESTOS CO., LTD.
Asbestos fibre (CAF) textiles, "Permanite."
WALKER, C. AND W., LTD.
WILSON PIPE FITTINGS, LTD.

360 FABRICATIONS

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A.P.V. CO., LTD., THE.
Aluminium, s.s., reactor core tanks.
B.A.P. (WELDING ACCESSORIES DIV.), LTD.
C. & M. ENGINEERING CO., LTD.
Welded M.S. $\frac{1}{4}$ to $\frac{1}{2}$ plate up to 5 tons.
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ADAMSON, DANIEL, AND CO., LTD.
Medium, heavy; pressure vessels; carbon, alloy, steels.
ADAMSON, JOSEPH AND CO., LTD.
ALLEN, ALFRED, AND SON, LTD.
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ALLEN, EDGAR, AND CO., LTD.
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ALLEN, W. G., AND SON (TIPTON), LTD.
Steel, alloy, s.s., aluminium; to 10 tons.
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Fabrications including machining.
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Aluminium pressing, spinning, welding.
ANGLO-SWEDISH ELECTRIC WELDING CO., LTD., THE.
Vessels, pipe lines, tank repair service.
ARCHITECTURAL AND INDUSTRIAL MODEL CO., LTD.
Models.
ASHMORE, BENSON, PEASE AND CO., LTD.
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AUSTIN, JAMES, AND SONS (DEWSBURY), LTD.
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AYRSHIRE DOCKYARD CO., LTD.
BABCOCK AND WILCOX, LTD.
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BADDELEY ENGINEERING, D.S. CO., LTD.
BAIN, W. B., AND CO., LTD.
BALFOUR, HENRY, AND CO., LTD.
JOHN BARNSLEY AND SONS, LTD.
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BARNABY ENGINEERING CO. (1950), LTD.
All types.
BATES BROS. (ENGINEERS), LTD.
BAYLISS JONES AND BAYLISS, LTD.
Steel fabrications up to 50 tons weight machining facilities. CO_2 welding.
BELL PRECISION ENGINEERING CO., LTD.
BENNIS COMBUSTION, LTD.
M.s., s.s., pressure vessels.
BIRMINGHAM AND BLACKBURN CONSTRUCTION CO., LTD.
Plate to $\frac{1}{2}$ in.; m.s., s.s. light alloys.
BIRWELCO, LTD.
Steel, aluminium, pressure vessels.

360 FABRICATIONS (contd.)

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FREDERICK BRABY AND CO., LTD.
BRAITHWAITE AND CO. STRUCTURAL, LTD.
Pressed steel tanks.
BRITISH ACHESON ELECTRODES, LTD.
"Karbate" impervious graphite corrosion-resistant chemical plant.
BRITISH APPLIANCES MFG. CO., LTD., THE.
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BRITISH REFRASIL CO., LTD., THE.
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BROWN, E. G., AND CO., LTD.
Fabrications in all metals, made to order.
BROWN, JOHN (S.E.N.D.), LTD.
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BURNLEY AIRCRAFT PRODUCTS, LTD.
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BUTTERLEY CO., LTD., THE.
Welded, all types.
BUTTERFIELD, LTD., W. P.
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CAMBRIAN PLANT, LTD.
CASS AND PHILLIP, LTD.
CENTRAX, LTD.
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CHESTERFIELD TUBE CO., LTD., THE.
Seamless steel headers, pressure vessels.
CHILLCOTTS, LTD.
CLARKE, CHAPMAN AND CO., LTD.
Pressure vessels.
COCHRAN AND CO., ANNAN, LTD.
Pressure vessels.
COLVIN-SMITH, LTD.
Steelwork.
CORNERCROFT, LTD.
Sheet metal work, spinnings, pressings.
COVENTRY RADIATOR AND PRESSWORK CO., LTD.
Pressings, sheet metal.
CRADLEY BOILER CO., LTD.
Cylindrical vessels, air receivers.
CRAVEN BROS. (MANCHESTER), LTD.
Steel; heat treatment.
CRAVENS, LTD.
S.s. pipework, pressure vessels, etc.
CRITTALL-LUXFER, LTD.
Aluminium, steel vessels, etc. to ¼ in. plate.
CROFTS (ENGINEERS), LTD.
Steel.
CUPROCYL, LTD.
Non-ferrous tanks.
DARHAM INDUSTRIES (LONDON), LTD.
DAVEY, PAXMAN AND CO., LTD.
Aluminium, steel, s.s.; clad, lead-lined.
DAVISON AND CO. (HEXHAM), LTD.
DELANEY GALLAY, LTD.
DENDY, RICHARD, AND ASSOC.
DISTINGTON ENGINEERING CO., LTD.
Heavy steel self-supporting chimneys.
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EMPYRIUM WELDING AND MFG. CO., LTD.
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ENGELHARD INDUSTRIES, LTD.
Precious metal.
ENGLISH ELECTRIC CO., LTD., THE.
ENTWISLE AND GASS, LTD.
EVANS, J., AND SON (PORTSMOUTH), LTD.
FAIREY CO., LTD., THE.
Aluminium alloy, mild and H.T. steel, stainless steel.
FAIRLEEDE ENGINEERING, LTD.
Mild steel and stainless steel up to 50 tons.
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FARR, EDWARD, LTD.
Welded steel plate, rolled sections.
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Reinforced plastic.
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Welded, riveted, construction; heavy, light.
FIRTH BLAKELEY SONS AND CO., LTD.
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FIRTH, THOS., AND JOHN BROWN, LTD.
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GRAVINER MANUFACTURING CO., LTD.
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GRIFFITHS, A. E. (SMETHWICK), LTD.
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HALL BROTHERS (NETHERTON), LTD.
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S.s.
HARLAND AND WOLFF, LTD.
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HARVEY, G. A., AND CO. (LONDON), LTD.
HEAD, WRIGHTSON, TEESDALE, LTD.
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HILLS (WEST BROMWICH), LTD.
HOPKINS, G., AND SONS, LTD.
S.s. plant.
HORSELEY BRIDGE AND THOMAS PIGGOTT, LTD.
IDE, C. F., ENGINEERING, LTD.
IRVING ENGINEERING CO., LTD.
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JEAVONS, E. E., AND CO., LTD.
JENKINS, ROBERT, AND CO., LTD.
Pressure, storage, vessels; m.s., s.s., clad; non-ferrous.
JENKINSON, W. G., LTD.
Lead, s.s., alum, plastic.
JOHNSTONE, ARCHIBALD (ENGINEERS), LTD.
KENYON, WM., AND SONS, LTD.
LEE (GUS) AND BOSWELL, LTD.
LONGCLOSE ENGINEERING CO., LTD., THE.
S.s.
LONGFIELDS, LTD.
LORD, R., AND SONS, LTD.
Pressure vessels and fabrications in m.s. and s.s.
LOW, ARCHIBALD, AND SONS, LTD.
LUCAS, JOSEPH, LTD.
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MAITLANDS (METAL WORKS), LTD.
Steam jacketed pans and tanks.
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MARSTON EXCELSIOR, LTD.
Light alloy and non-ferrous metals.
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Chemical anti-corrosion plant vessels (A).
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Steel stockholders.
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MIDLAND INDUSTRIES, LTD.
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MILES DEVELOPMENT PRODUCTS, LTD.
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MILLER, P. AND L., LTD.
MILLS, G., (ENGRS.), LTD.
MILLSPAUGH, LTD.
MOFFAT ENGINEERING CO., LTD.
MOORE, W. AND E., LTD.
Tanks, platework.
MOORE'S (WALLISDOWN), LTD.
S.s., aluminium.
MORTON, FRANCIS, AND CO., LTD.
Fabrications.
MORTON MACHINE CO., LTD.
Aluminium, m.s., s.s., special designs.
MOTHERWELL BRIDGE AND ENGINEERING CO., LTD., THE.
Designers, erectors, reactor, pressure vessels.
NEILL, W., AND SON (ST. HELENS), LTD.
M.s., s.s., aluminium to 1½ in thick.
NOBRAC CARBON, LTD.
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Steel prototype specialists.
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Prefabricated buildings, complete labour camps.
SIMON-CARVES, LTD.
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SKINNINGROVE IRON CO., LTD.
Steelwork, welded, riveted; rails, roof supports.
SMITH, W. H., AND CO. (WHITCHURCH), LTD.
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Steel tanks, pressure vessels.
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STAINLESS STEEL PROFILE CUTTERS, LTD.
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Tanks, lined.
TEES SIDE BRIDGE AND ENGINEERING WORKS, LTD.
Tanks, plate work, class 2 welding.
THOMPSON BROS. (BILSTON), LTD.
THOMPSON, JOHN, LTD.
Pressure vessels.
TRANSFORMER AND ELECTRICAL CO., LTD., THE.
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General sheet metal.
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Medium.
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Process plant.
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UNIVERSAL BOILERS AND ENGINEERING CO., LTD.
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WARD, THOS. W., LTD.
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WHITELEY-READ ENGINEERS, LTD.
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Ducting, pressure vessels.
YORKSHIRE ENGINEERING AND WELDING CO. (BRADFORD), LTD.
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TUPHOLME, GEORGE E., AND CO., LTD.
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UNISTRUT DIVISION OF SANKEY SHELDON, LTD.
Heavy storage racking, space division.
WELCONSTRUCT CO., LTD.
All types of steel storage equipment.

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ALFA-LAVAL, CO., LTD.
AUTO-KLEAN STRAINERS, LTD.
Oil, chemical, water.
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BIRMINGHAM PROTECTIVE CLOTHING CO.
BIVAC AIR CO., LTD.
"Clear Flo" air.
BLACKMAN, KEITH, LTD.
BOBY, WILLIAM, AND CO., LTD.
BOULTON, WILLIAM, LTD.
BOUND BROOK BEARINGS, LTD.
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Filtration media.
CHAMBERS FILTER BAG CO., LTD., THE.
CONTROLLED HEAT AND AIR, LTD.
Wet and dry dust filters.
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DANFOSS (LONDON), LTD.
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DAVEY, PAXMAN AND CO., LTD.
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DOULTON INDUSTRIAL PORCELAINS, LTD.
Gas, liquid, ceramic.
ENDECOTTS (FILTERS), LTD.
Wire gauze filter elements.
FAIREY CO., LTD., THE.
Gas circuit and B.F.E.D. filters.
FIBREGLASS, LTD.
Air filters.
FIRKINS, G. AND A., LTD.
HEATHER FILTERS, LTD.
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HOLMES, W. C., AND CO., LTD.
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INCANDESCENT HEAT CO., LTD.
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MATTHEWS AND YATES, LTD.
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Automatic fabric, automatic viscous unit type air filters.
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PHILIPS ELECTRICAL, LTD.
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PRESS, WILLIAM AND SON, LTD.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
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Agent.
SILICA GEL, LTD.
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SIMON-CARVES, LTD.
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STILLITE PRODUCTS, LTD.
Mineral wool pads.
STOCKDALE ENGINEERING, LTD.
Rotary vacuum, pressure disc.
STREAM-LINE FILTERS, LTD.
Oil, water, air, chemical solutions, specials.
STURTEVANT ENGINEERING CO., LTD.
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TECALEMIT, LTD.
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THERMIX INDUSTRIES, LTD.
High efficiency cloth dust arrestor systems.
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TOWNSON AND MERCER, LTD.
Radio-active; pump unit.
WALKER, P. M., AND CO. (HALIFAX), LTD.
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WRIGHTS FORGE AND ENG. CO., LTD.
VERSIL, LTD.
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VISCO ENGINEERING CO., LTD., THE.
Air.
VOKES, LTD.
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FIRE ARMOUR, LTD.
FOAMITE, LTD.
GENT AND CO., LTD.
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KIDDE, WALTER CO., LTD., THE.
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MAXIM SILENCERS, LTD.
Silencers of the high velocity industrial and combined spark arrestor types.
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MINERVA DETECTOR CO., LTD., THE.
Nuclear system detectors, control units, signal panels.
NU-SWIFT, LTD.
Portable extinguishers, pressure-charge operated.
PERKINS GAS TURBINES, LTD.
PILLINGER, G. C., AND CO., LTD.
Automatic water distribution systems.
PYRENE CO., LTD., THE.
Hand extinguishers, installations, detecting alarms.
SPRAYED INSULATIONS, LTD.
"Silbestos" sprayed asbestos.
THERMAL CONTROL CO., LTD.
TURNERS ASBESTOS CEMENT CO., LTD.
Sprayed "Limpet" asbestos.
UNISTRUT DIVISION OF SANKEY SHELDON, LTD.
Fire resistance space division.
VACUUM RESEARCH (CAMBRIDGE), LTD.
High vacuum, sintering and annealing.

364 FLAW DETECTION

C.N.S. INSTRUMENTS, LTD.
Ultrasonic; bonding; graphite; eddy current; tube tester.
ESAB, LTD.
Magnetic.
AIRMEC, LTD.
AVELEY ELECTRIC, LTD.
Ultrasonic flaw detection.
ASSOCIATED ELECTRICAL INDUSTRIES (RUGBY), LTD.
Leak detectors.
CAWKELL RESEARCH AND ELECTRONICS, LTD.
EXTRUDEX, LTD.
FALK, M., AND CO., LTD.
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GAMMA-RAYS, LTD.
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GAMMAX, LTD.
Testing by all N.D.T. methods.
GLASS DEVELOPMENTS, LTD.
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METAL AND PIPELINE ENDURANCE, LTD.
Weld inspection and radiography.
PANTAK, LTD.
Magnetic crack detectors.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
SOLUS-SCHALL, LTD.
Ultrasonic, magnetic, eddy current, consultants.
SPERRY GYROSCOPE CO., LTD.
Eddy current.
ULTRASONOSCOPE CO. (LONDON), LTD.
For metals and explosive materials.
UNIT SUPERHEATER AND PIPE CO., LTD., THE.
Ultrasonic, gas leak testing.
VICKERS-ARMSTRONGS (ENGINEERS), LTD.
WELDING SUPPLIES, LTD.
WILFLO PRODUCTS, LTD.
Magnetic crack detectors.

365 FORGINGS

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Aluminium.
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BAYLISS, JONES AND BAYLISS, LTD.
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Stainless steel.
REYNOLDS TUBE CO., LTD.
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Alloy, carbon steel forgings and rolled rings.
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Drop.
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366 FUEL ELEMENTS

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Mg, Al, Zr, Ni, V, Be sheaths; Zr, s.s. supports. Zirconium, niobium, vanadium, beryllium supports in zirconium and stainless steel.
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367 FUME TREATMENT

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BATES BROS. (ENGINEERS), LTD.
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MANCUNA ENGINEERING, LTD.
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SIMON-CARVES, LTD.
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368 FURNACES

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Degussa.
CATTERSON-SMITH, R. M., LTD.
Electric resistance; 450°C to 1,750°C; special.
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Vacuum melting, sintering; associated equipment.
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ELECTRIC RESISTANCE FURNACE CO., LTD.
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HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
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HEAD WRIGHTSON PROCESSES, LTD.
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Electrically heated furnaces and ovens.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
Salt bath heat treatment.
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KEPSTON, LTD.
LEYBOLD VACUUM SALES, LTD.
MELDRUMS-FLOOD-PAGE, LTD.
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Electric. Melting and heat treatment of all metals; special elements for stress relieving.
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Coke, gas, oil and electric. Salamander crucibles.
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Carbon, sulphur, muffle, kilns and ash.
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GRUBB, SIR HOWARD, PARSONS AND CO., LTD.
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INTERNATIONAL GAS DETECTORS, LTD.
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Vacuum.

370 GAUGES

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Manometers, high and low pressure.
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BUDENBERG GAUGE CO., LTD.
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GLASS DEVELOPMENTS, LTD.
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LINTRONIC, LTD.
Pressure, differential.
MERCER, THOMAS, LTD.
Gauges, all types.
MOLLART ENGINEERING CO., LTD., THE.
Comparators, gauges.
MULLARD EQUIPMENT, LTD.
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PAYNE AND GRIFFITHS, LTD.
Pressure, vacuum—all types.
RHODES, B. AND SON, LTD.
Sight flow.
SMITH, SYDNEY, AND SONS (NOTTINGHAM), LTD.
Level, pressure, vacuum.
SUPERHEATER CO., LTD., THE.

371 GEARS

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Demountable pirani, discharge tube.
ALLEN, W. H., SONS AND CO., LTD.
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All types of gears; worm, helical, bevel gear units and variable speed units.
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Precision gears and gearboxes.
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Servomechanism.
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Asbestos reinforced plastics.
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High efficiency spur gears for servos, gearboxes.
TURBINE GEARS, LTD.
VACTRIC (CONTROL EQUIPMENT), LTD.
International frame size gearheads, small precision gears.
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Strateline speed reducers, Varatio positive V.S.
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WEYERS BROS., LTD.
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Cutting, boxes, reduction, increasing, units, motor.

372 GENERATORS

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Aircraft generators and invertors.
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A.C. to 3,500 kW and 6.6 kV; d.c., 4,000 kW.
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Generators up to 1,000 kW.
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High performance, and associated voltage control.

372 GENERATORS (contd.)

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"Stamford" standard, newphase E.S. alternators.
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Glassware.
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Specialists, graded seals, quartz, cones, sockets.
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FAIREY CO., LTD., THE.
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HAWKER-SIDDELEY NUCLEAR POWER CO., LTD.
Impermeable graphite for fuel cans, sleeves, heat exch., etc.
HEAD WRIGHTSON PROCESSES, LTD.
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Reactor grade.
NOBRAC CARBON, LTD.
Heaters, anodes, crucibles, seals, bearings, fabrications.
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Graphite, heat exchangers, condensers, pumps, bursting discs.
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Equipment for machining graphite.
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Laying.

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PLESSEY NUCLEONICS, LTD.
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RANK CINTEL, LTD.
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SAVAGE AND PARSONS, LTD.
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TOWERS, J. W., AND CO., LTD.

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Oil burners.
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R.F. induction, dielectric plastic sheet welders.
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Dielectric heaters.
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STABILAG CO., LTD.
STANDARD AND POCHIN BROS., LTD., THE.
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Air.
TETRA ENGINEERING CO., LTD., THE.
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THERMO ENGINEERS, LTD.
Air.
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Electric, wide range.
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FAIRLEEDE ENGINEERING, LTD.
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HEAD WRIGHTSON TEESDALE, LTD.
HEAT EXCHANGERS, LTD.
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S.s.
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Infinitely variable high pressure-pumps, valves, High speed piston type pumps for all duties.
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Complete systems; valves, pumps, motors, etc.
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Mains frequency.
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KETAY, LTD.
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Measurement and control of flow, level, temperatures, pressure.
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Precision manometers, design capacity.
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Pneumatic transmitters, controllers, relays, boosters.
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COUNTING INSTRUMENTS, LTD.
Mechanical and electro-magnetic counters.
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Electrical measuring instruments.
CROSBY VALVE AND ENGINEERING CO.
Controllers, regulators, transmitters, transducers and positioners.
DARTON, F., AND CO., LTD.
DEVON INSTRUMENTS, LTD.
Timers.
DEWRANCE AND CO., LTD.
DRAYTON REGULATOR AND INSTRUMENT CO., LTD.
Temperature, pressure; controllers.
DUKES AND BRIGGS ENGINEERING CO., LTD.
ELCONTROL, LTD.
Timers, weight control, level, flame monitoring.
ELECTRICAL REMOTE CONTROL CO., LTD.
Special purpose, motor driven potentiometers, etc.
ELECTRICALS, LTD.
Agent.
ELECTROFLO METERS CO., LTD.
ELECTRONIC MACHINE CO., LTD.
Counters, timers, special purpose.
ELECTRONIC SWITCHGEAR (LONDON), LTD.
Conductivity bridges, recorders; fluid level.
ELGA PRODUCTS, LTD.
Conductivity.
ELLIOTT NUCLEONICS, LTD.
ENGELHARD INDUSTRIES, LTD.
Specials.
ENGLISH CLOCK SYSTEMS.
Time recording equipment.
ETHER, LTD.
EVERSHED AND VIGNOLES, LTD.
Pressure, level, specific gravity, purity.
FAIREY CO., LTD., THE.
FARNELL INSTRUMENTS, LTD.
FIELDEN ELECTRONICS, LTD.
FINDLAY AND CO.
FIRTH CLEVELAND INSTRUMENTS, LTD.
Flow counters, indicators, controllers.
FISHER GOVERNOR CO., LTD.
Pneumatic pressure and level controls.
FLIGHT REFUELLING, LTD.
FOXBORO-YOXALL, LTD.

384 INSTRUMENTS, PROCESS CONTROL (contd.)

FRASER, W. J., AND CO., LTD.
Process control engineers.
GRAVINER MANUFACTURING CO., LTD.
Thermostats, temperature-control switches.
HARCOURT, DAVID, LTD.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
HEATH, HICKS AND PERKEN, LTD.
Temperature indicating, recording, meteorological.
HONEYWELL CONTROLS, LTD.
HUNT AND MITTON, LTD.
Temperature, flow, level, pressure, etc.
INFRA RED DEVELOPMENT CO., LTD.
INTEGRA LEEDS AND NORTHRUP, LTD.
INTEGRAL, LTD.
INTERNATIONAL GAS DETECTORS, LTD.
IONIC INSTRUMENTS (LONDON), LTD.
Liquid level indicators, contents gauges.
KELVIN AND HUGHES (INDUSTRIAL), LTD.
Temperature, pressure, combustion, draught, flow.
KENT, GEORGE, LTD.
Differential-pressure.
KIDDE, WALTER, CO., LTD., THE.
Liquid level indicators.
KILPATRICK, JAMES, AND SON, LTD.
KLINGER, RICHARD, LTD.
Liquid level.
LANCASHIRE DYNAMO ELECTRONIC PRODUCTS, LTD.
Electronic, any input above 1 mV, output up to 1,000 h.p.
LAND PYROMETERS, LTD.
Pyrometers, surface, suction, radiation, immersion, thermocouple accessories.
LEA RECORDER CO., LTD.
LEEDS METER CO., LTD., THE.
Water, allied liquids, recording instruments.
LINTOTT, H. AND E., LTD.
LIQUID SYSTEMS, LTD.
LOCK, A. M., AND CO., LTD.
pH controllers, reaction controllers, temperature controllers, humidity controllers, level indicators.
McKELLEN, S. D., LTD.
MALONE INSTRUMENT CO., LTD., THE.
MANCHESTER WATER METER CO., LTD., THE.
MEASUREMENT, LTD.
Sholof indicator.
MECHANISM, LTD.
Electro-mechanical; pressure.
MINERVA LABORATORIES (INSTRUMENTS), LTD.
Specialized electro-mechanical.
MUIRHEAD AND CO., LTD.
Magslips, synchros, servometers, amplifiers.
MUNRO, R. W., LTD.
NAPIER, D., AND SON, LTD.
NEGRETTI AND ZAMBRA, LTD.
Temperature, pressure, humidity, level, transmission, control.
NEILL, WM., AND SON (ST. HELENS), LTD.
Level indicator.
NEWMAN INDUSTRIES, LTD.
Electronic.
NEW WESTERN (ENGINEERING), LTD.
Contractors.
NORTHERN SCIENTIFIC EQUIPMENT, LTD.
PARMEKO, LTD.
Furnace; photo-cell, magnetic amplifiers.
PEEBLES, BRUCE AND CO., LTD.
(Electronics division).
PLATON, G. A., LTD.
Controllers, meters, alarms, flow.
PLESSEY CO., LTD.
Pneumatic, electric and electronic.
PROCESS CONTROL GEAR, LTD.
Thermostats, all types.
PULLIN, R. B., AND CO., LTD.
PYE, W. G., AND CO., LTD.
Process analysers (chromatograph).
RATZER AND CO., LTD.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
ROBINSON, D., AND CO.
Sequence controllers, process timers.
ROBINSON, F. C., AND PARTNERS, LTD.
Batch counting, level control.
ROTAMETER MANUFACTURING CO., LTD.
Flow meters, alarms, density, level gauges.
ROTHERHAM AND SONS, LTD.
SAMSON CONTROLS (LONDON), LTD.
Pneumatically and self-operated.
SANDERS, W. H., (ELECTRONICS), LTD.
SIGMA INSTRUMENT CO., LTD.
Automatic, inspection, sorting machines.
SPIRAX-SARCO, LTD.
Thermostatic control.
STURDY ELECTRIC CO., LTD.
SYKES, W. R., INTERLOCKING SIGNAL CO., LTD.
TAYLOR CONTROLS, LTD.
Transcope, fuiscope instruments, for most uses.
TECHNE (CAMBRIDGE), LTD.
"Tempunit" temperature control unit (liquids).
TEDDINGTON INDUSTRIAL EQUIPMENT, LTD.
Valves (solenoid, motorized, thermostatic pressure); development.
TELECOMMUNICATION INSTRUMENTS, LTD.
TELEMETERS, LTD.
Telemetering, automatic sequence controllers.
TEST EQUIPMENT, LTD.
THERMOCONTROL INSTALLATIONS CO., LTD.
TYER AND CO., LTD.
Tem-Con temperature, humidity controllers.
UNITY HEATING, LTD.
Temperature.
UNIVERSAL CONTROL EQUIPMENT, LTD.
Conductivity, safety controls, interlocks.
VENNER ELECTRONICS, LTD.
VERNON INSTRUMENTS CO., LTD.
VICKERYS, LTD.
Flow controllers, abrasion and corrosion-resisting.
WEST INSTRUMENT, LTD.
WEYERS BROS., LTD.
WHITE AND RICHES, LTD.
Development.
WIDGERY DEVELOPMENTS, LTD.
Manometers, pressure, vacuum.
WYKEHAM, W., AND CO., LTD.

385 INSTRUMENTS, TEST

A.C.M. ELECTRONICS, LTD.
Development and design.
RCA GREAT BRITAIN, LTD.
Complete range of electronic and electrical.
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Transistor sets, telemetry UHF, VHF units.
ACCURATE RECORDING INSTRUMENT CO.
ADVANCE COMPONENTS, LTD.
Signal generators, Q meters, valve voltmeters.
AIRFLOW DEVELOPMENTS, LTD.
Portable air and gas flow testing sets, pitot tubes, manometers.
ALLIED ELECTRONICS, LTD.
ANDEC, LTD.
ARMSTRONG WHITWORTH EQUIPMENT.
Transistorised galvanometer amplifiers; sweep frequency oscillator and vibration controller; RF wobbulator.
AVELEY ELECTRIC, LTD.
AVO, LTD.
Transistor analyser, valve characteristic meter, electrical, electronic.
BARNET INSTRUMENTS, LTD.
Test gauges, instruments for testing pressure and vacuum gauges.
BATY, J. E., AND CO., LTD.
Extensometers, portable hardness testers.
BOULTON PAUL AIRCRAFT, LTD.
Measuring bridges, transducers, stabilised power units.
BRITISH COMMUNICATIONS CORPORATION, LTD.
BRITISH PHYSICAL LABORATORIES.
Valve voltmeter, bridges, insulation tester.
BUTLER, HOWARD, LTD.
BUTLER RADIO MFG. CO. (ROCHESTER), LTD.
CAMBRIDGE INSTRUMENT CO., LTD.
Electrical, mechanical, chemical, physical.
CAWKELL RESEARCH AND ELECTRONICS, LTD.
Oscilloscopes; pulse, delay generators; supplies.
CINEMA TELEVISION, LTD.
COSSOR INSTRUMENTS, LTD.
Oscillographs, pulse generators, transistorised power supplies.
CROMPTON PARKINSON, LTD.
Various, including "Tong-Test" range.
CURRAN, JOHN, LTD.
Neutron diffraction spectrometers, collimators.
DAVIS, JOHN, AND SONS (DERBY), LTD.
Barometers, anemometers, water gauges.
DAWE INSTRUMENTS, LTD.
Pulse generators.
DORAN INSTRUMENT CO., LTD.
DYNATRON RADIO, LTD.
Pulse generators, power units.
ENGLISH ELECTRIC CO., LTD., THE.
ERICSSON TELEPHONES, LTD.
Timers, pulse generators, counting units.
EVANS ELECTROSELENIUM, LTD.
Blood cell counter.
EVERSHED AND VIGNOLES, LTD.
Ohmmeters, voltmeters, ammeters, polarographs.
FAIREY CO., LTD., THE.
Nuclear magnetic resonance spectrometer.
FARNELL INSTRUMENTS, LTD.
FLEISCHMANN (LONDON), LTD.
High vacuum.
FLEMING RADIO (DEVELOPMENTS), LTD.
Pulse generator.
FURZEHILL LABORATORIES, LTD.
Oscilloscopes, voltmeters, signal sources, etc.
GENEVAC, LTD.
GLASS DEVELOPMENTS, LTD.
Instruments test.
GOODMANS INDUSTRIES, LTD.
Vibration measuring and electronic control equipment.
GRESHAM TRANSFORMERS, LTD.
HARRIS, PHILIP, LTD.
HATFIELD INSTRUMENTS, LTD.
Polyphase power amplifiers, radio frequency admittance bridges.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
HAWNT AND CO., LTD.
HENDREY RELAYS, LTD.
Flameproofness testing equipment.
HILGER AND WATTS, LTD.
Spectrographs, spectrophotometers, absorptiometers.
IONIC INSTRUMENTS (LONDON), LTD.
Pig detectors, holiday detectors inspection cameras, prototypes.
IRWIN, E. G., AND PARTNERS, LTD.
Design and manufacture of special test gear.
KAPPA MOISTURE METERS, LTD.
LANGHAM THOMPSON, J., LTD.
Instruments, test.
LION ELECTRONIC DEVELOPMENTS, LTD.
LIVINGSTONE LABORATORIES, LTD.
Oscilloscopes, bridges, analysers, voltmeters.
LYONS, CLAUDE, LTD.
Variable autotransformers, automatic-voltage, regulators and stabilisers, power-supplies.
MADAN, CHARLES S., AND CO., LTD.
Pressure tests up to 100,000 p.s.i.
MARCONI INSTRUMENTS, LTD.
Equipment, bridges, voltmeters, etc.
MEASURING INSTRUMENTS (PULLIN), LTD.
MERCER, THOMAS, LTD.
Comparators, chronometers, test sets.
METRIX INSTRUMENTS, LTD.
Electrical and electronic test and measuring instruments.
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MILES-HIVOLT, LTD.
Insulation testing, high voltage measuring equipment.
Test equipment.
MUIRHEAD AND CO., LTD.
Transfer function and wave analysers.
MULLARD EQUIPMENT, LTD.
Analysers, pulse generators, oscilloscopes, magnetic resonance.
NALDER BROS. AND THOMPSON, LTD.
Dynamometers, ammeters, voltmeters, wattmeters and power factor meters.
NASH AND THOMPSON, LTD.
Electronic and mechanical measuring.
NEO-ELECTRICAL INDUSTRIES, LTD.
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Manufacturers of inspection equipment including profile projectors and magnifiers.
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PYE, W. G., AND CO., LTD.
RACAL INSTRUMENTS, LTD.
Digital frequency meters, counters, timers, tachometers.
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Commercialisation from prototypes.
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Insulation resistance test sets, ammeters, voltmeters, etc.
REID, A., MANUFACTURING CO., LTD.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Signal generators, oscilloscopes d.c. amplifiers, bridges.
RIVLIN INSTRUMENTS, LTD.
ROBINSON, F. C., AND PARTNERS, LTD.
Electronic test equipment to specification.
SANDERS, W. H., (ELECTRONICS), LTD.
SANGAMO WESTON, LTD.
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Vibrators, amplifiers, G. meters, oscillators.
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SHACKMAN, D., AND SONS.
SHANDON SCIENTIFIC CO., LTD.
Microscopes, potentiostat, analytic.
SHORT BROS. AND HARLAND, LTD.
Control system analyser low frequency oscillator.
SOLARTRON ELECTRONIC GROUP, LTD.
Oscilloscopes, pulse generators, recorders.
SOUTHERN INSTRUMENTS, LTD.
Oscilloscopes, recording cameras; absorption, turbidity meters.
STRATTON AND CO., LTD.
Communications receivers.
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Wide range.
TECHNE (CAMBRIDGE), LTD.
Gelation timer, viscometer.
TELEMECHANICS, LTD.
Frequency measurement, insulation test, development facilities.
TINSLEY, H., AND CO., LTD.
TRUMETER CO., LTD.
UNION RADIO, LTD.
VENNER ELECTRONICS, LTD.
WAYNE-KERR LABORATORIES, LTD.
WEST LONDON IRON AND WIRE WORKS, LTD.
Pulse generators, oscilloscopes, power units timers.
WINSTON ELECTRONICS, LTD.
ZEAL, G. H., LTD.
All types of thermometers and hydrometers.

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ATTWATER AND SONS, LTD.
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Electro-ceramic insulators in Steatite and other materials.
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BRITISH REFRASIL CO., LTD., THE.
Low boron silica textiles for up to 1,000°C.
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Porcelain, supporting ironwork.
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Porcelain.
EVODE, LTD.
Adhesive tape.
FIBREGLASS, LTD.
Glass yarns and laminate reinforcements.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
Silicone resins, rubbers, greases, fluids.
INSULATING COMPONENTS AND MATERIALS, LTD.
IOCO, LTD.
LINTRONIC, LTD.
Insulation, electrical (portable 0–10kV) test unit.
LODGE PLUGS, LTD.
"Sintox" ceramic.
MICA AND MICANITE SUPPLIES, LTD.
MICALECTRIC, LTD.
Mica condenser plates for capacitors.
MICANITE AND INSULATORS CO., LTD., THE.
Mica, Micanite, Samica, Paxolin, Panilax, Armatite.
MINNESOTA MINING AND MANUFACTURING CO., LTD.
"Scotch" brand electrical tapes.
PERMALI, LTD.
Laminates, densified wood; glassfibre, reinforced.
PLASTICABLE, LTD.
P.v.c. sleeving.
POLYPENCO, LTD.
Fluorocarbon t.f.e. (p.t.f.e.) tape, sleeving, sheet, rod and machined parts.
ROYAL WORCESTER INDUSTRIAL CERAMICS, LTD.
Ceramic insulators.
SHELL CHEMICAL CO., LTD.
STEEL, J. M., AND CO., LTD.
SYMONS, H. D., AND CO., LTD.
Flexible.
TAYLOR, TUNNICLIFF AND CO., LTD.
Ceramics for all electrical purposes.
TUFNOL, LTD.
Tufnol.
UNITED INSULATOR DIVISION OF T.C.C.
Insulating electrical ceramics, "Unikote" coatings.
WANDLESIDE CABLE WORKS, LTD.
P.t.f.e./glass laminates.

387 INSULATION, THERMAL

P.H. THERMAL PRODUCTS, LTD.
Cylinder and tank jackets, mineral fibre, felt and rigid-pipe insulation.
BATES BROS. (ENGINEERS), LTD.
Sound and thermal.
BELL'S ASBESTOS AND ENGINEERING, LTD.
BRITISH REFRASIL CO., LTD., THE.
Low boron silica textiles for up to 1,000°C.
BUSH BEACH AND SEGNER BAYLEY, LTD.
Ceramics.
CAPE ASBESTOS CO., LTD.
Caposite, Caposil, Capoplastic, Rocksil.
CAPE BUILDING PRODUCTS, LTD., THE.
Asbestolux insulation board.
CHEMICAL AND INSULATING CO., LTD., THE.
85% magnesia, meta-, dextramite, silicate; armouring, finishing cpds.
COLUMBIAN-GENERAL BLACKS, LTD.
Pure lamp black.
CONSETT IRON CO., LTD.
High temperature refractories; zircon, zirconia.
CORK INSULATION AND ASBESTOS, LTD
Eldorite mineral wool, Kalail calcium silicate.
CORRANCE AND YUILL, LTD.
Asbestos products.
CURTIS, A. L. (ONX), LTD.
Refractory materials.
DARLINGTON INSULATION CO., LTD., THE.
Insulation contractors—heat, cold and sound.
DAY, J., AND CO. (DERBY WORKS), LTD.
"Daystar," 1,000°C.; coverings.
DELANEY GALLAY, LTD.
DRAFTSELE, LTD.
ENGLISH ASBESTOS (SALES), LTD.
EXPANDED PLASTICS, LTD.
EXPANDED RUBBER CO., LTD.
Onazote for low temperature insulation.
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Structural and plant.
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Plastics, asbestos, mineral, glass fibre.
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"Ciment" fondu high alumina-cement, Secar 250 white calcium-aluminate cement.
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Composite panels.
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Vermiculite.
MOLER PRODUCTS, LTD.
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NORTON GRINDING WHEEL CO., LTD.
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ONAZOTE INSULATION CO., LTD.
PERMALI, LTD.
Cast resins.
REFRACTORY MOULDINGS AND CASTINGS, LTD.
ROBERTS, J. W., LTD.
Sprayed limpet asbestos.
ROBERTSON, J. R. A.
SPRAYED INSULATIONS, LTD.
Sprayed asbestos, etc.
STILLITE PRODUCTS, LTD.
Mineral wool in all forms.
SYDDALL, ARTHUR (GRANTHAM), LTD.
Asbestos sheeting.
THERMAL SYNDICATE, LTD., THE.
TOMLINSONS (ROCHDALE), LTD.
"Seelheet" panels.
UNILOCK PARTITIONS, LTD.
Styrotherm expanded polystyrene slabs, mouldings, etc.
UNITED INSULATOR DIVISION OF T.C.C.
"Unikote" coatings.
VERSIL, LTD.
Glass fibre.

388 IRRADIATION, LABORATORY

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Linear accelerator beam facilities.
FRASER, W. J., AND CO., LTD.
Designers.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
Glove boxes, hoists, design and construction, radiation labs.
IRWIN, E. G., AND PARTNERS, LTD.
Design and supply of complete irradiation facilities.
LABGEAR, LTD.
Protection and warning instrumentation.
MILES-HIVOLT, LTD.
PALATINE (SURBITON), LTD.
SPEMBLY, LTD.
Hot plates. Specimen polishing equipment.
VICKERS-ARMSTRONGS (AIRCRAFT), LTD.

389 IRRADIATION UNITS

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FRASER, W. J., AND CO., LTD.
Designers and fabricators.
HOBSON, H. M., LTD.
Honeycomb isotope units.
HUNSLET PRECISION ENGINEERING, LTD.
Co 60 and Cs 137 therapy and research units.
MILES DEVELOPMENT PRODUCTS, LTD.
Sub critical reactor assemblies, with pulsed neutron generators.
MILES-HIVOLT, LTD.
NATIONAL PLASTICS (SALES), LTD.
NUCLEAR CHEMICAL PLANT, LTD.
Plant for processing irradiated elements.
NUCLEAR ENGINEERING, LTD.
Research, processing and medical therapy.
OWEN ORGANISATION, THE.
Irradiation units for sterilization of blankets, surgical instruments and dressings, drugs, etc.
UNITED KINGDOM ATOMIC ENERGY AUTHORITY.
VICKERS-ARMSTRONGS (AIRCRAFT), LTD.

390 ISOTOPE APPLICATIONS

BALDWIN INDUSTRIAL CONTROLS.
Beta and gamma thickness gauges.
BURNDEPT, LTD.
Portable thickness gauge, radiation switch.
DAVY AND UNITED ENGINEERING CO., LTD.
Radiation thickness gauges for rolled strip.
EKCO ELECTRONICS, LTD.
Thickness, density, wear, pipe wall gauges.
GAMMA-RAYS, LTD.
Equipment for special isotope applications.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
HAWNT AND CO., LTD.
HENDREY RELAYS, LTD.
Bore hole survey.
HUNSLET PRECISION ENGINEERING, LTD.
Co 60 and Cs 137 therapy and research units.
LABGEAR, LTD.
Consultancy service.
LOCK, A. M., AND CO., LTD.
Level controllers using isotopes.
MADDOCK, J. O., LTD.
MILES-HIVOLT, LTD.
MINERVA DETECTOR CO. LTD., THE.
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RESEARCH AND CONTROL INSTRUMENTS, LTD.
Medical and industrial.
SIMON-CARVES, LTD.
UNITED KINGDOM ATOMIC ENERGY AUTHORITY.

391 ISOTOPES

GAMMAX, LTD.
With or without remote control.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
Short half-life isotopes and activation analysis.
MAITLANDS (METAL WORKS), LTD.
RADIOCHEMICAL CENTRE, THE.
Processed; sealed sources; labelled compounds.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Research.
20TH CENTURY ELECTRONICS, LTD.
Stable; B-10, B-11, C-14, N-15, O-18, etc.
UNITED KINGDOM ATOMIC ENERGY AUTHORITY.

392 JOINTINGS; Packings

B.B. CHEMICAL CO., LTD.
"Bostik" adhesives, coatings, compositions.
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Synth. rubber.
ARMSTRONG PATENTS CO., LTD.
Helicoil inserts.
BELDAM ASBESTOS CO., LTD.
BELL'S ASBESTOS AND ENGINEERING, LTD.
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COOPER AND CO. (BIRMINGHAM), LTD.
CRANE PACKING, LTD.
DENTON AND CO.
Rubber and asbestos.
ENGLISH ASBESTOS (SALES), LTD.
Asbestos cloths, yarns, tapes.
GRAPHITE PRODUCTS, LTD.
Jointings, packings, lubricants.
HALL AND HALL, LTD.
HEINKE, C. E., RUBBER MANUFACTURERS LTD.
HOLLYWOOD, WM., AND CO., LTD.
Asbestos manufacturers.
HOWARD BROS.
Compressed asbestos fibre.
KEIRBY, EDWARD, AND CO., LTD.
KLINGER, RICHARD, LTD.
Compressed asbestos, p.t.f.e., silicone rubber.
KNITMESH, LTD.
MINNESOTA MINING AND MANUFACTURING, CO., LTD.
"Scotchcast" brand resin.
NORTON, F. A., AND SONS, LTD.
PIONEER OILSEALING AND MOULDING CO., LTD.
Hydraulic, pneumatic, high vacuum.
ROBERTS, A., AND CO. (HECKMONDWIKE), LTD.
Asbestos, textiles.
RUBBAGLAS, LTD.
"Rubbaglex" sheeting.
SHELL CHEMICAL CO., LTD.
TRIST, RONALD, AND CO., LTD.
Seatrist moulded packings, seals.
TURNER BROS. ASBESTOS CO., LTD.
Asbestos fibre (CAF) textiles, "Permanite".
UNITED STATES METALLIC PACKING CO., LTD.
Metallic.
UNIVERSAL METALLIC PACKING CO., LTD.
WALKER, JAMES, AND CO., LTD.
WELLWORTHY, LTD.
Wellseal compound.
WHITBY AND CHANDLER, LTD.
H.P. compressed asbestos joints, P.t.f.e., p.v.c., synthetic rubber hose, mouldings, rings.
WITTY AND WYATT, LTD.
Asbestos gaskets, laggings.
WOOD BROS. AND CO. (GASKETS), LTD.
Gaskets, "Bobrok" metal and metal/asbestos joints; "Spiretz" spiral wound gaskets.
WRIGHT, T., (BRADFORD), LTD.

393 LABORATORY EQUIPMENT

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Manometers, glove box depression indicators, fans, filters, etc.
AMAL, LTD.
Bunsen burners.
AVELEY ELECTRIC, LTD.
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BAIRD AND TATLOCK (LONDON), LTD.
CAMLAB (GLASS), LTD.
CYGNET JOINERY, LTD.
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DORAN INSTRUMENT CO., LTD.
ELECTRICALS, LTD.
Suppliers of.
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ELECTROTHERMAL ENGINEERING, LTD.
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ENDECOTTS (FILTERS), LTD.
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FEEDBACK, LTD.
D.C. amplifiers, power packs, signal generators.
FIBRECLAD, LTD.
Reinforced plastic, benches, sinks, trays, etc.
GALLENKAMP, A., AND CO., LTD.
GREY AND MARTEN, LTD.
Lead benches.
GRIFFIN AND GEORGE (SALES), LTD.
HENDREY RELAYS, LTD.
Mercury vapour concentration meters.
ISOPAD, LTD.
Electric heating mantles.
JOHNSON, MATTHEY AND CO., LTD.
Furnaces.
LABORATORY APPARATUS AND GLASS BLOWING CO.
Glass, s.s., plastic.
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Plastics ware.

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Packaged lead shielding chambers; lead bricks; isotope containers, etc.
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BIRWELCO, LTD.
Lined tanks.
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Glass blocks.
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Bricks, coffins, containers.
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Tubes, containers.
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Fabricated vessels, vessels and pipes, ducting and room linings.
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High purity lead.
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GREY AND MARTEN, LTD.
Castings, fillings, fabrications, pots, linings.
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INSPECTION EQUIPMENT, LTD.
Lead ply, lead doors, mobile screens, lead glass.
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JENKINSON, W. G., LTD.
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Bricks, washers, rings, wool, wire, tape and powder.
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Coated steel strip.
LUNEVALE PRODUCTS, LTD.
Compounds.
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Homogeneous lead linings.
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Lifts, lifting control systems.
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Hoists, blocks, jacks.
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Pneumatic hoists.
GOODWIN, ARNOLD, LTD.
LAKE AND ELLIOT, LTD.
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MARSH, H. S., LTD.
MARTONAIR, LTD.
Pneumatic hoists.
MOORE, W. AND E., LTD.
Winches, hoists, slings.
PARKER MITCHELL ENG. CO., LTD.
Special hoisting gear.
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Lined equipment, homogeneous lead linings.
WAKES AND LAMB.
WICKHAM ENGINEERING CO., LTD.
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MONSANTO CHEMICALS, LTD.
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Molybdenum disulphide, solid lubricating materials.
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Centralized, remotely controlled equipment.
GREASE APPLIANCE CO., LTD.
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Lubricating equipment and service.

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Automatic transfer.
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Special purpose grinding and polishing m/cs.
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TANGYES, LTD.
Heavy duty lathes; coil winders.

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Electronic automatic control of machine tools (e.g. centreless grinder control).
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Milling machines adapted for remote-control.
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Automatic cycle. Data fed.
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Range of portable power tools.
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Control to 2,500 p.s.i. 1,100°F.
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FAIREY CO., LTD., THE.
HALL ENGINEERING, LTD.
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Machining.
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Precision machining (including graphite).
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Light alloy pipes and fittings.
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Machining of stainless steel and all plastics.
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Special mechanisms, gears, racks.
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MILES DEVELOPMENT PRODUCTS, LTD.
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Gear cutting, heat treatment, plating.
WYCOMBE HIRE PLANT
Precision; prototypes; "one-offs".

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Alloy forgings.
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Electro-solenoids.
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ENGLISH STEEL MAGNET CORPORATION, LTD.
Permanent.
FAIREY CO., LTD., THE.
GENERAL ELECTRIC CO., LTD., THE.
Lifting, electro-magnetic.
HARVEY ELECTRONICS, LTD.
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Special.
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Ticonal permanent ferrites.
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Sintered permanent.
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ANGEL TRUCK CO., LTD.
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Mechanical handling trucks. (heavy turntables, etc.)
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Prime movers.
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Wheels, castors, bearings, etc.
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All types; capacity to 7½ tons.
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Re-rubbering wheels for mechanical-handling trucks.
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FISHER AND LUDLOW, LTD.
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Castors, wheels.
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Shield handling equipment.
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Hydraulic lifting trucks, stackers, drum, carboy and cylinder handling equipment.
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Diesel auto trucks; tractors, tipping trucks to 5 tons; trailers to 20 tons capacity.
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MATBRO, LTD.
Fork lift trucks from 4,000 lb to 10,000 lb, lift capacity. Tractor shovels, wheeled 2- and 4-wheel drive up to 100 h.p.
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MOXEY, LTD.
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Design development and manufacturing engineers.
OMIC, LTD.
Fork trucks; hand and electric pallet trucks.
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Fork (2,000–8,000 lb), reach and platform trucks and tugs, robot-controlled trucks, straddle carriers, lifting platforms.
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Special battery or engine driven.
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Industrial trucks, tractors and trailers.
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WARD, THOS. W., LTD.
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B.E.V. electric industrial trucks, tractors and locomotives.
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Range of mechanical sorting and feeding of component parts (e.g. motor valves).
ALLEN, W. G., AND SON (TIPTON), LTD.
Portable or fixed.
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Conveyors, elevators, hoists, loaders, stackers, etc.
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Platforms, special purpose conveyors.
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BROWN, W. W., AND PARTNERS, LTD.
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Belt, roller, chain; transfer tables.
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All types of engineering and manipulating systems.
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Overhead chain conveyors, floor conveyors, electric hoists, runways, grabs.
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Belt, slat, roller, portable and gravity.
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LINTOTT, H. AND E., LTD.
LISTER, R. A., AND CO., LTD.
Industrial power conveyors, portable or fixed, electrically operated.
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MANN, ALBERT, ENGINEERING CO., LTD.
Mechanical handling conveyors.
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MELDRUMS-FLOOD-PAGE, LTD.
MOFFAT ENGINEERING CO., LTD.
MORRIS, HERBERT, LTD.
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NELSON ENGINEERING CO., LTD., THE.
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Design, development and manufacturing engineers.
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All types.
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POWER JACKS, LTD.
PRESSOTURN, LTD.
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Light, medium and heavy duty design facilities.
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Special vibratory conveyors.
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THOMPSON, JOHN, LTD.
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VICKERS-ARMSTRONGS (AIRCRAFT), LTD.
VICTOR ELECTRICS, LTD.
WAKES AND LAMB.
WARD, THOS. W., LTD.
WESSEX INDUSTRIES (POOLE), LTD.
WEST'S GAS IMPROVEMENT CO., LTD.
Conveyors.
WHITELEY-READ ENGINEERS, LTD.
WICKHAM ENGINEERING CO., LTD.
WILSON, EDWARD, AND SON, LTD.
Belt conveyors—rubber, wire and nylon.

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C.N.S. INSTRUMENTS, LTD.
Extensometers, tachometer.
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Prototype, production, profile projector.
M.H.H. ENGINEERING CO., LTD.
Torque indicating wrenches and torque limiting screwdriver.
AIRTECH, LTD.
ALLTOOLS, LTD.
Load cells, 250 to 1,000,000 lb.
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Dynamic balancing, frequency meters.
AVERY, W. AND T., LTD.
BARRUS, E. P. (CONCESSIONAIRES), LTD.
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Steel.
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WELDING TECHNICAL SERVICES, LTD.
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WILSON PIPE FITTINGS, LTD.
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BLUNDELL AND CROMPTON, LTD.
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CIBA (A.R.L.), LTD.
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Constant tension.
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BURY FELT MANUFACTURING CO., LTD.
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CHEMICAL PIPE AND VESSEL CO., LTD.
CHEMIDUS PLASTICS, LTD.
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LITHOLITE INSULATORS AND ST. ALBANS MOULDINGS, LTD.
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Fabrication and design in Perspex, SRBF, SRBP, Darvic, etc.
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UNIVERSAL METAL PRODUCTS, LTD.
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Encapsulation.
WHITELEY ELECTRICAL RADIO CO., LTD.
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WYLON, LTD.
Linings, coverings, fabrications, machining.

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BRITISH COMPRESSED AIR SOCIETY.
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Pneumatic devices; purpose-designed, manufactured.
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FISHER GOVERNOR CO., LTD.
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Maxam fluid power equipment.
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SAMSON CONTROLS (LONDON), LTD.
SAUTER CONTROLS, LTD.
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As used in chemical processing.
BIRMINGHAM PROTECTIVE CLOTHING CO.
CHICHESTER RUBBER CO., LTD., THE.
Nat., synth. rubber Chirco gloves, gauntlets.
CITY UNIFORM MFG. CO., THE.
COMPTON, J., SONS AND WEBB, LTD.
Donkey jackets.
DUNLOP RUBBER CO., LTD.
Gloves, gauntlets, industrial aprons, industrial footwear, waterproof garments.
EASTWOOD PLASTICS, LTD.
Oversuits, overshoes, hoods, aprons, etc.
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Suits (suits with integral air ventilation), inflatable decontamination and changing rooms.
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Neoprene-rubber suits. Breathing and underwater apparatus.
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MELLOWHIDE PRODUCTS, LTD.
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NORTHIDE, LTD.
PLYSU PRODUCTS, LTD.
Unsupported p.v.c.; pressure ventilated.
PROTECTIVE FOOTWEAR SERVICE, LTD.
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Pulsafe industrial safety equipment.
SIEBE, GORMAN AND CO., LTD.
Respirators, harnesses, telephones, specials.
SPEMBLY, LTD.
Pressure ventilated. Air supply equipment.
STENHOUSE EQUIPMENT CO.
Gloves, goggles, respirators, safety belts. Hose respirators.
TEDSON, THORNLEY AND CO., LTD.
Leather, asbestos, cotton, p.v.c. industrial gloves.
TIMEG, LTD.
VARLEY, JAMES, AND CO., LTD.
Overalls, industrial.
VEEDIP, LTD.
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418 PULSE HEIGHT ANALYSERS

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FLEMING RADIO (DEVELOPMENTS), LTD.
LABGEAR, LTD.
Single channel motor driven scan.
MILES-HIVOLT, LTD.
Multi-channel (up to 400) with storage and print-out facilities.
MULLARD EQUIPMENT, LTD.
100-channels.
NUCLEAR ENTERPRISES (G.B.), LTD.
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PLESSEY CO., LTD.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
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419 PUMPS

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Glandless.
E.C.D., LTD.
Liquid, gas; chemical injection, metering.
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Boiler feed, glandless, vacuum process, submersible and chemical.
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Rotary and diffusion high vacuum pumps.
Q.V.F., LTD.
SPE CO., LTD.
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Vacuum, rotary, reciprocating.
ALLEN, W. H., SONS AND CO., LTD.
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ALLEY AND MACLELLAN (POLMADIE), LTD.
Vacuum.
APEX CONSTRUCTION, LTD.
Vacuum, rotary force, chemical, sanitory.
APPLETON AND HOWARD, LTD.
For chemical corrosive liquids.
AUTOMETRIC PUMPS, LTD.
Centrifugal, turbine, vacuum, gear, etc.
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BELL PRECISION ENGINEERING CO., LTD.
BERRY, HENRY, AND CO., LTD.
Hydraulic.
BIRKETT, T. M., BILLINGTON AND NEWTON, LTD.
Component parts.
BOVING AND CO., LTD.
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Vert. and horiz. self priming glandless vacuum extraction units.
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Submersible pumps, motors; propeller, centrifuge.
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CORNERCROFT, LTD.
CROWN PUMP MANUFACTURING CO., LTD.
Rotary gear and vane, hydraulic, submersible and centrifugal.
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DAWSON AND DOWNIE, LTD.
DENTON AND CO.
Pump lining with rubber.
DISTILLERS CO., LTD., THE.
DRYSDALE AND CO., LTD.
Large capacity centrifugal.
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High vacuum rotary, diffusion, vapour booster.
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Positive displacement.
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Hand, hydraulic.
FAWCETT PRESTON AND CO., LTD.
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FRASER, ANDREW, AND CO., LTD.
Hydraulic.
FRIEDENTHALS, LTD.
Steam reciprocating.
GENERAL ENGINEERING CO. (RADCLIFFE), LTD.
GENEVAC, LTD.
GILKES, GILBERT, AND GORDON, LTD.
Self-priming, centrifugal, multi-stage, circulating.
GIRDLESTONE PUMPS, LTD.
Centrifugal and diaphragm pumps.
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Vacuum.
GOODWIN, ARNOLD, LTD.
GWYNNES PUMPS, LTD.
Centrifugal, mixed flow, axial flow.
HALL ENGINEERING, LTD.
Special.
HAMWORTHY ENGINEERING, LTD.
Centrifugal, screw and gear pumps.
HARLAND ENGINEERING CO., LTD., THE.
Centrifugal.
HAYWARD TYLER AND CO., LTD.
Zero leakage, glandless, submersible, research facilities.
HICK HARGREAVES AND CO., LTD.
Rotary.
HOLDEN AND BROOKE, LTD.
Centrifugal, reciprocating.
HOLMAN BROS., LTD.
Goodyear axial flow.
HOWARD MECHANICAL DEVELOPMENTS, LTD.
HOWARD PNEUMATIC ENGINEERING CO., LTD., THE.
HYDRAULICS AND PNEUMATICS, LTD.
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JENSENS (SCIENTIFIC), LTD.
Mercury vapour in glass or silicone.
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KONTAK MANUFACTURING CO., LTD.
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Vacuum, pressure, non-lubricated rotary.
LAMONT, THOM., AND CO., LTD.
Steam and electric, reciprocating.
LAYCOCK ENGINEERING, LTD.
LEE, HOWL AND CO., LTD.
LEYBOLD VACUUM SALES, LTD.
LONGCLOSE ENGINEERING CO., LTD., THE.
S.s. centrifugal.
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Allis-Chalmers solids handling pumps.
MADAN, CHARLES S., AND CO., LTD.
Air operated.
MATHER AND PLATT, LTD.
Centrifugal.
MERRILL PUMPS, LTD.
Glandless, self-priming, diaphragm.
METERING PUMPS.
Variable stroke, metering.
MITCHELL, L. A., LTD.
Acid.
MONO PUMPS, LTD.
Rotary, positive-acting, self-priming.
NEUMO, LTD.
Pneumatic, proportioning, transfer.
NEWBURGH ENGINEERING CO., LTD.
NORTHEY ROTARY COMPRESSORS, LTD.
Vacuum pumps.
PILLINGER, G. C. AND CO., LTD.
PLENTY AND SON, LTD.
High pressure feed.
PULLEN, F. A., AND CO., LTD.
PULSOMETER ENGINEERING CO., LTD., THE.
For all duties, centrifugal, rotary, reciprocating and vacuum.
RANSOMES AND RAPIER, LTD.
Self-priming.
REAVELL AND CO., LTD.
Vacuum.

419 PUMPS (contd.)

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Vacuum.
ROTHERHAM AND SONS, LTD.
SAUNDERS VALVE CO., LTD.
Centrifugal.
SAVERY, THOMAS, PUMPS, LTD.
Small capacity, annular piston.
SCREW MACHINE PRODUCTS, LTD.
Units.
SIGMUND PUMPS, LTD.
Centrifugal.
SLACK AND PARR, LTD.
STANHOPE ENGINEERS (BRADFORD), LTD.
STOTHERT AND PITT, LTD.
Screw and rotary displacement pumps and centrifugal pumps.
SULZER BROS. (LONDON), LTD.
TANGYES, LTD.
Reciprocating, centrifugal, high pressure.
LAMONT, THOM, AND CO., LTD.
THOMAS AND SON (WORCESTER), LTD.
Recipracating machinery.
TOWLER BROS. (PATENTS), LTD.
High speed, oil, high pressure.
URQUHARTS (1926), LTD.
Volumetric metering.
VACUUM INDUSTRIAL APPLICATIONS, LTD.
VACUUM METALLURGICAL DEVELOPMENTS, LTD.
Vacuum, rotary-vane, roots, diffusion.
VACUUM RESEARCH (CAMBRIDGE), LTD.
High vacuum, roots, glycerine; mercury vapour.
VARLEY-FMC, LTD.
Gear, turbine.
VICKERS-ARMSTRONGS (ENGINEERS), LTD.
WAKES AND LAMB.
WALLWIN (PUMPS), LTD.
WICKHAM ENGINEERING CO., LTD.
Sludge.
WILKINSON RUBBER LINATEX, LTD.
Linatex rubber-lined centrifugal, diaphragm.
WILLIAMS AND JAMES (ENGINEERS), LTD.
Hydraulic and vacuum.
WILSON, ALEXANDER (ABERDEEN), LTD.
WORTHINGTON-SIMPSON, LTD.
All types.
WRIGHT ELECTRIC MOTORS (HALIFAX), LTD.
Electro suds-circulating.

420 PURIFICATION PLANT

BALFOUR, HENRY, AND CO., LTD.
BRITISH OXYGEN ENGINEERING, LTD.
CONSTRUCTIONAL ENGINEERING CO., LTD., THE.
ENGELHARD INDUSTRIES, LTD.
Gas.
FRASER, W. J., AND CO., LTD.
Radio-active and chemical units.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
Inert gases i.e. argon.
HEAD WRIGHTSON PROCESSES, LTD.
Tubular, air-cooled.
INCANDESCENT HEAT CO., LTD., THE.
Especially for gas purification.
METAFILTRATION CO., LTD., THE.
PATERSON ENGINEERING CO., LTD., THE.
Filtration, clarifiers, ion exchange, chlorinators, softening.
PEABODY, LTD.
Gas.
PULSOMETER ENGINEERING CO., LTD., THE.
WALKER, C. AND W., LTD.
Gas cleaning.
WESTERN DETAIL MANUFACTURERS, LTD.

421 RADIATION DETECTORS

DERBY LUMINESCENTS, LTD.
Scintillators, scintillator screens, zinc and cadmium sulphide single crystals.
EKCO ELECTRONICS, LTD.
Monitors.
ELLIOTT NUCLEONICS, LTD.
Installed.
ERICSSON TELEPHONES, LTD.
Portable monitors.
FLEMING RADIO (DEVELOPMENTS), LTD.
HAWNT AND CO., LTD.
HILGER AND WATTS, LTD.
Thermopiles, photoconductive cells, crystal phosphors.
LABGEAR, LTD.
G-M scintillation low chamber and proportional.
LOCK, A. M., AND CO., LTD.
Gamma, alarms, radiation monitors.
MILES-HIVOLT, LTD.
Multi-channel (up to 400) with storage and print-out facilities.
NUCLEAR ENTERPRISES (G.B.), LTD.
Body counting installations.
PLESSEY CO., LTD.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
G-M and scintillation.
20TH CENTURY ELECTRONICS, LTD.
Ion, fission, chambers; G-M, neutrons, X-ray.

422 RADIATION MEASUREMENT

B. AND K. LABORATORIES, LTD.
(A) Nuclear Corporation of America, U.S.A.
E.M.I. ELECTRONICS, LTD.
Photomultiplier tubes.
P.A.M., LTD.
ASSOCIATED ELECTRICAL INDUSTRIES, LTD. (Instrumentation division).
Flux radiation.
AVIMO, LTD.
AVO, LTD.
Hot spot monitors, Radiac survey meters.
BALDWIN INDUSTRIAL CONTROLS.
Ionization chambers and film badge densitometers.
BRITISH PHYSICAL LABORATORIES.
Linear amplifiers.
BURNDEPT, LTD.
Ratemeters, α, β, γ, fast neutron counters.
CINEMA TELEVISION, LTD.
DERBY LUMINESCENTS, LTD.
Scintillators, scintillator screens, zinc and cadmium sulphide single crystals.
DYNATRON RADIO, LTD.
Amplifiers, scalers, probes.
EKCO ELECTRONICS, LTD.
Ratemeters, scalers, electrometers, G-M equipment.
ELECTRONIC MACHINE CO., LTD.
Radiation monitoring service.
ERICSSON TELEPHONES, LTD.
Amplifier; EHT, quench units, ratemeters, scalers.
EVANS ELECTROSELENIUM, LTD.
Densitometer.
FALK, M., AND CO., LTD.
Instruments (A).
FLEMING RADIO (DEVELOPMENTS), LTD.
Ratemeters.
GENERAL RADIOLOGICAL, LTD.
HALL ENGINEERING, LTD.
Ion chamber equipment.
HAWNT AND CO., LTD.
Laboratory instruments, accessories.
HENDREY RELAYS, LTD.
Borehole gamma survey equipment.
ILFORD, LTD.
Photographic emulsions.
LABGEAR, LTD.
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MARSHALL OF CAMBRIDGE ELECTRONICS, LTD.
Scalers, integrators, pulse generators.
MILES-HIVOLT, LTD.
Multi-channel (up to 400) with storage and print-out facilities.
MULLARD, LTD.
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NORTHEY ROTARY COMPRESSORS, LTD.
Vacuum pumps.
NUCLEAR ENTERPRISES (G.B.), LTD.
NUCLEAR RESEARCH APPLICATIONS, LTD.
Laboratory instruments.
OPTICAL WORKS, LTD.
Cerenkov blocks.
PLESSEY NUCLEONICS, LTD.
Radiation detectors — ionisation chambers, fission counters.
RADIATION MONITORS, LTD.
Utility Geiger counter.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Ratemeters, scalers, G-M counters, EHT units.
SARGROVE ELECTRONICS, LTD.
STONEBRIDGE ELECTRICAL CO., LTD., THE.
TOWERS, J. W., AND CO., LTD.
Monitors, detectors, planchets.
TUBELA ENGINEERING CO., LTD.
VACUUM INDUSTRIAL APPLICATIONS, LTD.

423 RADIOGRAPHY

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BUTTERFIELD, W. P., LTD.
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Gamma equipment.
GAMMA-RAYS, LTD.
Gamma-rays; X-rays, ultrasonic, magnetic, etc.
GAMMAX, LTD.
HUNSLET PRECISION ENGINEERING, LTD.
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INDUSTRIAL RADIOGRAPHY (NDT), LTD.
INSPECTION EQUIPMENT, LTD.
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KODAK, LTD.
X-ray films.
MACHLETT X-RAY TUBES (GT. BRITAIN), LTD.
MARCONI INSTRUMENTS, LTD.
Industrial X-ray.
MOTHERWELL BRIDGE AND ENGINEERING CO., LTD., THE.
Services on world-wide basis.
NUCLEAR ENGINEERING, LTD.
Gamma source transport, storage containers.
PALMER AERO PRODUCTS, LTD.
PANTAK, LTD.
X-ray equipment; X-ray inspection.
POWELL DUFFRYN CARBON PRODUCTS, LTD.
Graphite testing.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Portable, constant potential, image intensifiers, etc.
SOLUS-SCHALL, LTD.
Industrial X-ray, gamma.
UNIT SUPERHEATER AND PIPE CO., LTD., THE.
Lloyd's approved.
WATSON AND SONS (ELECTRO-MEDICAL), LTD.
X-ray apparatus.
WELDING SUPPLIES, LTD.
WRIGHTS FORGE AND ENG. CO., LTD.

424 REACTORS, NUCLEAR

B. AND K. LABORATORIES, LTD.
Student type, sub-critical (A).
A.E.I.-JOHN THOMPSON NUCLEAR ENERGY CO., LTD.
ADAMSON, DANIEL, AND CO., LTD.
ATOMIC POWER CONSTRUCTIONS, LTD.
Base-load power stations.
BABCOCK AND WILCOX, LTD.
Gas cooled, water cooled.
ENGLISH ELECTRIC CO., LTD., THE.
Base-load power stations.
FAIREY CO., LTD., THE.
Zero energy experimental reactors, in-pile facilities and loops.
GENERAL ELECTRIC CO., LTD., THE.
Base-load power stations.
GRAVINER MANUFACTURING CO., LTD.
Specialised machining, reactor reflectors, etc.
DE HAVILLAND ENGINE CO., LTD., THE.
Admiralty marine propulsion studies, primary circuit equipment (HERO).
HAWKER SIDDELEY, JOHN BROWN NUCLEAR CONSTRUCTION, LTD.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
JASON—research and training, OMR—ship, power and heat.
HEAD WRIGHTSON PROCESSES, LTD.
HUMPHREYS AND GLASGOW, LTD.
PWR, Babcock and Wilcox, Ltd., collaborators.
MILES-HIVOLT, LTD.
Sub-critical assemblies.
MILES DEVELOPMENT PRODUCTS, LTD.
Sub-critical reactor assemblies, with pulsed neutron generators.
MITCHELL ENGINEERING, LTD.
PBWR, with A.M.F. Atomics, G.N.E.C., marine propulsion in association with Combustion Engineering, Inc.
MOTHERWELL BRIDGE AND ENGINEERING CO., LTD., THE.
Nuclear.
THE NUCLEAR POWER PLANT CO., LTD.
Base-load power stations.
THOMPSON, JOHN, LTD.
VICKERS-ARMSTRONGS (AIRCRAFT), LTD.
Simulators.
VICKERS-NUCLEAR ENGINEERING, LTD.
WRIGHTS FORGE AND ENG. CO., LTD.

425 RECORDERS

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Analogue to digital data tabulator.
IEC-SIEGER, LTD.
ACCURATE RECORDING INSTRUMENT CO.
ASSOCIATED ELECTRICAL INDUSTRIES, LTD. (Instrumentation division.)
Potentiometric.
BAILEY METERS AND CONTROLS, LTD.
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BRITISH ROTOTHERM CO., LTD., THE.
Pressure, temperature, thermostats.
CAMBRIDGE INSTRUMENT CO., LTD.
Galvanometer types; photographic (Duddell); electronic.
DEVON INSTRUMENTS, LTD.
Chart motors.
DOBBIE MCINNES (ELECTRONICS), LTD.
DRAYTON REGULATOR AND INSTRUMENT CO., LTD.
ELLIOTT NUCLEONICS, LTD.
EVERSHED AND VIGNOLES, LTD.
FIELDEN ELECTRONICS, LTD.
FOSTER INSTRUMENT CO., LTD.
Temperature indicators, controllers.
GENT AND CO., LTD.
GLEDHILL-BROOK TIME RECORDERS, LTD., THE.
Equipment time
HENDREY RELAYS, LTD.
Single channel spark recorders.
HONEYWELL CONTROLS, LTD.
Flux, power period, flow, pressure temperature.
INTEGRA LEEDS AND NORTHRUP, LTD.
KELVIN AND HUGHES (INDUSTRIAL), LTD.
High frequency, galvanometer.
KENT, GEORGE, LTD.
Flow, pressure, temperature, power level, radiation, flux.
LANCASHIRE DYNAMO ELECTRONIC PRODUCTS, LTD.
Strip and disc, 1 mV FSD, upwards. 1 sec. response.
LEA RECORDER CO., LTD.

425 RECORDERS (contd.)

MERCER, THOMAS, LTD.
Recording units.
METRIX INSTRUMENTS, LTD.
Voltage, current, power, frequency time.
NALDER BROS. AND THOMPSON, LTD.
PULLIN, R. B., AND CO., LTD.
RECORD ELECTRICAL CO., LTD., THE.
Microammeters, milliammeters, ammeters, voltmeters, etc.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Oscilloscripts, temperature, flow, conductivity, pressure, level.
ROBINSON, F. C., AND PARTNERS, LTD.
Operation, event, single- and multi-pen.
SENSITISED COATINGS, LTD.
SERVIS RECORDERS, LTD.
Running and idle time. Production fault indicating.
SHANDON SCIENTIFIC CO., LTD.
Microvoltmeter, vibration temperature.
SMITH, SYDNEY, AND SONS (NOTTINGHAM), LTD.
TERRASPAN, LTD.
TEST EQUIPMENT, LTD.

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CABLEFORM, LTD.
CARRIER ENGINEERING CO., LTD.
CROWTHORN ENGINEERING CO., LTD.
DOUGLAS, WILLIAM, AND SONS (ENGINEERING), LTD.
HEAT TRANSFER, LTD.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
"Arcton" refrigerants.
LIGHTFOOT REFRIGERATION CO., LTD., THE.
Freon. ammonia.
MAITLANDS (METAL WORKS), LTD.
METROPOLITAN REFRIGERATION, LTD.
Bulk CO_2 storage (A).
MINING AND CHEMICAL PRODUCTS, LTD.
Thermoelectric cooling.
PORTER, ALFRED, (SALES), LTD.
Centrifugal and reciprocating compressors.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Gas liquefier, cold box, etc.
SAUTER CONTROLS, LTD.
Electronic, pneumatic and electro-mechanical controls.
STERNE, L. AND CO., LTD.
UNITED AIR COIL, LTD.
WEATHERFOIL, LTD.
WESTERN DETAIL MANUFACTURERS, LTD.
YORK SHIPLEY, LTD.

427 REMOTE HANDLING

B.M.B. (SALES), LTD.
H.L. INSTRUMENTS, LTD.
Tongs, head assemblies, dryboxes and fittings.
ALLEN, P. W., AND CO.
Periscopes, telescopic system, lighting.
BARNSLEY, JOHN, AND SONS, LTD.
Special purpose cranes.
BERK, F. W., AND CO., LTD.
Zinc bromide solution.
BRITISH PAINTS, LTD.
Strippable paint.
CHICHESTER RUBBER CO., LTD., THE.
Drybox hotbox gauntlets rubber, Neoprene "Chirco."
EASTWOOD PLASTICS, LTD.
Plastics glove-box bags, sleeves, tong gaiters.
EVANS, J., AND SON (PORTSMOUTH), LTD.
FAIREY CO., LTD., THE.
FLEETLANDS, LTD.
FRASER, W. J., AND CO., LTD.
Designers and fabricators.
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Power-operated manipulators.
GENERAL RADIOLOGICAL, LTD.
GREY AND MARTEN, LTD.
Lead spheres, bungs; mirror, aperture units.
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HALL ENGINEERING, LTD.
Glove boxes.
HOBSON, H. M., LTD.
Master slave manipulators.
HULL, F., AND SONS, LTD.
INTERNATIONAL ENGINEERING CONCESSIONAIRES, LTD.
Dry boxes.
IRWIN, E. G., AND PARTNERS, LTD.
All types of handling and manipulating systems.
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LUCAS, JOSEPH, LTD.
Design, fabrication capacity.
MARCONI'S WIRELESS TELEGRAPH CO., LTD.
Closed circuit television.
MARINE AND INDUSTRIAL PLASTICS, LTD.
MOORE'S (WALLISDOWN), LTD.
Glove boxes.
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Design, development and manufacturing engineers.
NUCLEAR RESEARCH APPLICATIONS, LTD.
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OPTICAL WORKS, LTD.
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Automatic door opening device and special installations (structures and mechanisms).
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PARKER MITCHELL ENG. CO., LTD.
Up to 4,000 lb.
PYE, LTD.
RHYMNEY ENGINEERING CO., LTD.
Mechanical, electrical, hydraulic, pneumatic, design facilities.
SAVAGE AND PARSONS, LTD.
Tools, specials, master slave manipulators, powered manipulators.
SCREW MACHINE PRODUCTS, LTD.
Equipment, components, assemblies.
SEALEY ENGINEERING CO., LTD.
Devices.
SETON CREAGHE ENGINEERING CO., LTD.
X-ray diffractometers; X-ray camera (cassette); dry boxes (rotary); self-seal-couplings (flexible).
SINEX ENGINEERING CO., LTD.
Automatic weighing and proportioning plant.
SPEMBLY, LTD.
TELEFLEX PRODUCTS, LTD.
Manipulators.
TOWERS, J. W., AND CO., LTD.
Glove boxes, lead bricks, castles.
TOWNSON AND MERCER, LTD.
Glove cabinets, rigid, flexible; handling tongs.
UNIBRIX RADIATION SHIELDINGS, LTD.
VICKERS-ARMSTRONGS (AIRCRAFT), LTD.
WESTERN DETAIL MANUFACTURERS, LTD.

428 RUBBER COMPS.

A.V.A., LTD.
Moulded or bonded to metal. Natural or synthetic.
ANGUS, GEORGE, AND CO., LTD.
Synth. and silicone rubbers.
JOHN BULL RUBBER CO., LTD.
CHICHESTER RUBBER CO., LTD., THE.
Compression, precision mouldings; latex dippings.
DENTON AND CO.
Mechanical rubbers, plastic components.
DUNLOP RUBBER CO., LTD.
Synthetic and natural.
EMPIRE RUBBER CO.
Mouldings, sponge, metal bonded.
HALL AND HALL, LTD.
HEINKE, C. E., RUBBER MANUFACTURERS, LTD.
Gaskets, mouldings, extrusions, hose, diaphragms, sealing rings, etc.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
Silicone rubbers, gums, pastes.
NORTHERN RUBBER CO., LTD., THE.
PLESSEY CO., LTD.
Radar absorbent material.
ST. HELENS CABLE AND RUBBER CO., LTD.
Mechanical mouldings, extrusions, etc.
SHELL CHEMICAL CO., LTD.
TRIST, RONALD AND CO., LTD.
Seatrist silicone rubbers.

429 SEALS

N.G.N. ELECTRICAL, LTD.
Oil seals and O rings in patented "Nygon" synthetic rubber.
ANGUS, GEORGE, AND CO., LTD.
Synth. and silicone rubbers.
BEAKBANE, HENRY (FORTOX), LTD.
Standard, oil-free, self-lubricating.
CHICHESTER RUBBER CO., LTD., THE.
Oil seals, O rings, latex seals.
CRANE PACKING, LTD.
Mechanical shaft seals.
DANFOSS (LONDON), LTD.
Shaft.
DOWTY SEALS, LTD.
O rectangular, U and flange seals, bonded seals and details.
DUNLOP RUBBER CO., LTD.
Rubber and silicone rubber.
EXPANDED RUBBER CO., LTD.
Rubazote soft expanded rubber; strips, gaskets.
FLEXIBOX, LTD.
Mechanical seals for pumps, blowers, etc.
FLIGHT REFUELLING, LTD.
Seal testing facilities.
HALL AND HALL, LTD.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
Impregnated graphite shaft seals, etc.
HEINKE, C. E., RUBBER MANUFACTURERS, LTD.
HELLERMANN, LTD.
Plugs and sockets, and water- and pressure-proof seals.
LODGE PLUGS, LTD.
Metal/ceramic vacuum.
MERCER, THOMAS, LTD.
Nilos grease retaining seals.
MORGAN CRUCIBLE CO., LTD., THE.
Morganite carbon.
PIONEER OILSEALING AND MOULDING CO., LTD.
Rotary shaft, reciprocating, mechanical face, pressure.
POLYPENCO, LTD.
Nylon and p.t.f.e. seals, packings, gaskets, etc.
TRIST, RONALD AND CO., LTD.
Seatrist T-Y glands.
UNITED STATES METALLIC PACKING CO., LTD.
Balanced rotary.
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High vacuum, sliding, rotary.
WESTON, C. AND CO., LTD.
Leather, synthetic rubber, split, O rings mechanical.

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APPLEBY AND IRELAND, LTD.
Servo mechanism.
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BRITISH ARCA REGULATORS, LTD.
BRITISH COMPRESSED AIR SOCIETY.
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FAIREY CO., LTD., THE.
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Gears, bearings, baseplates, etc., for prototypes.
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VACTRIC (CONTROL EQUIPMENT), LTD.
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ASSOCIATED LEAD MANUFACTURERS, LTD.
Lead containers for isotopes.
BATES BROS. (ENGINEERS), LTD.
ENTHOVEN, H. J., AND SONS, LTD.
Isotopes, waste, irradiated elements.
FAIREY CO., LTD., THE.
Handling flasks.
GAMMA-RAYS, LTD.
Gamma-ray equipment for all industrial applications.
GRAVINER MANUFACTURING CO., LTD.
Lead-shielded containers.
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HAWNT AND CO., LTD.
INSPECTION EQUIPMENT, LTD.
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SOLUS-SCHALL, LTD.
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VICKERS-ARMSTRONGS (AIRCRAFT), LTD.
WESTOVER NUCLEAR EQUIPMENT, LTD.
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ALEXANDER CONTROLS, LTD.
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CHANCE-PILKINGTON OPTICAL WORKS.
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MENDIP (CHEMICAL ENGINEERING), LTD.
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Polythene blocks.
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SOLUS-SCHALL, LTD.
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Fluids and greases, insulating varnishes, resins and rubbers.
PANAX EQUIPMENT, LTD.
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Experimental loops and rigs (in-pile and out-pile).
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Ledex, rotary solenoids.
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Complete range A.C. and D.C.
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Maxam fluid power equipment.
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PHILLIPS CONTROL (G.B.), LTD.
Complete range, A.C. and D.C.
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Laminated.
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MIRRLEES WATSON CO., LTD., THE.
NELSON ENGINEERING CO., LTD, THE.
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Diesel.
PETBOW, LTD.
Diesel driven.
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Steam boilers for all purposes.
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BROTHERHOOD, PETER, LTD.
Turbines.
BROWN, JOHN, (S.E.N.D.), LTD.
Turbines.
CALOMAX (ENGINEERS), LTD.
CLARKE, CHAPMAN AND CO., LTD.
Drums, headers, elements.
COCHRAN AND CO ANNAN, LTD.
Shell type boiler for steam or hot water generator.
COLLIER AND COLLIER, LTD.
Universal hose clips.
COPES REGULATORS, LTD.
Feed water regulators. High and low water alarms. Desuperheaters. Pump governors.
CRADLEY BOILER CO., LTD.
Boilers.
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Shell, water tube, waste heat boilers.
FOSTER WHEELER, LTD.
FOSTER YATES AND THOM, LTD.
Shell and water tube type boilers.
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Combustion engineers.
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Complete condensing plant, auxiliaries, evaporators.
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INTERNATIONAL COMBUSTION (NUCLEAR APPLICATIONS), LTD.
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Fully automatic, gas, oil-fired boilers.
LANCASTER AND TONGE, LTD.
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MAXIM SILENCERS, LTD.
Heat recovery silencers for hot water or steam.
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Condenser water boxes in reinforced resin.
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Steam traps mech. and thermostatic and accessories.
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PARSONS, C. A., AND CO., LTD.
PRIOR STOKERS, LTD.
RATZER AND CO., LTD.
RICHARDSONS, WESTGARTH AND CO., LTD.
Turbines; distillation; feed-heating; condensing.
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Steam-raising equipment.
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Traps, strainers, sight glasses.
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STEAM STORAGE CO., LTD.
Steam and hot water accumulators, heat recovery.
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Shell-type boilers.
SUPERHEATER CO., LTD., THE.
Steam generators.
THOMPSON, JOHN, LTD.
Boilers, desuperheaters.
UNITED STATES METALLIC PACKING CO., LTD.
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VICKERS-ARMSTRONGS (ENGINEERS), LTD.
WATSON, H. T., LTD.
Spray nozzles, orifice metering plates, strainers.
WIDNES WELDING CO.
Condensers.
WORTHINGTON-SIMPSON, LTD.
Feed heating, air ejectors.

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APPLEBY-FRODINGHAM STEEL CO.
M.s., low-alloy; plates, sections.
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S.s.
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COLVILLE CONSTRUCTIONAL CO., LTD.
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M.s. plates, bars, sections and special steels.
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Carbon and alloy, high speed and tool.
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Carbon and alloy steels to all specifications.
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HIGH DUTY ALLOYS, LTD.
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LEE, ARTHUR, AND SONS, LTD.
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LEES, J. B. AND S., LTD.
Hardened, tempered, cold rolled strip.
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Concrete reinforcing steel.
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Solid steel blocks.
MULBERRY CO., THE

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PARK GATE IRON AND STEEL CO., LTD., THE.
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STEEL COMPANY OF WALES, LTD., THE.
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STEWARTS AND LLOYDS, LTD.
WESTMAN, ERNEST B., LTD.
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BRITISH INDUSTRIAL ENGINEERING CO., LTD.
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Adjustable steel framing for all constructional purposes.
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Design, fabrication, erection.
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RESEARCH AND CONTROL INSTRUMENTS, LTD.
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SEALEY ENGINEERING CO., LTD.
SITE INVESTIGATIONS CO., LTD.
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Push-button switches.
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Panels, contactors, relays, timers.
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BROOKHIRST IGRANIC, LTD.
BURTON GRIFFITHS AND CO., LTD.
Limit switches.
CABLEFORM, LTD.
CHILTON ELECTRIC PRODUCTS, LTD.
Miniature circuit breakers, solenoid, rotary switches.
CRAIG AND DERRICOTT, LTD.
Limit, rotary, mini-, push-button switches.
CROMPTON PARKINSON, LTD.
Oil-break and air-break.
DORMAN AND SMITH, LTD.
L.T. switchgear and distribution gear, including miniature circuit breakers.
ENGLISH ELECTRIC CO., LTD., THE.
FORTIPHONE, LTD.
FYFE, WILSON AND CO., LTD.
GEIPEL, WILLIAM, LTD.
JOHNSON AND PHILLIPS, LTD.
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Standard and special purpose motor control.
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Switch and fusegear to 400 kV.
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Switchboards, control desks, junction boxes.
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Design and manufacture of heavy duty manual and remote control switchgear.
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Switchgear—arc-resisting contacts.
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MORRIS, J., ELECTRICAL ENGINEERING CO., LTD.
NELSON ENGINEERING CO., LTD., THE.
NELSON, W. AND H., LTD.
NETTLEFOLD AND MOSER, LTD.
OTTERMILL SWITCHGEAR, LTD.
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OXHYCARBON CO., LTD.
PETBOW, LTD.
Control cubicles.
PYE, LTD.
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To 15 kV, 350 MVA; breakers, transformers.
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15-amp. push-button.
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WESTOOL, LTD.
WHIPP AND BOURNE, LTD.
WILCOX, EDWARD, AND CO., LTD.
Re-wirable, H.R.C., in-built indicators.
YORKSHIRE SWITCHGEAR AND ENGINEERING CO., LTD.
Control, relay boards, circuit breakers.

443 THERMOCOUPLES

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Mineral insulated flexible thermocouples.
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Base metals and noble metals.
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ENGELHARD INDUSTRIES, LTD.
Precious metal.
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FOSTER INSTRUMENT CO., LTD.
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Development of special techniques.
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Sole agent for "Chromel" and "Alumel" alloys.
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Pyrotenax-mineral insulated.
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Wire, miniature.
ROYAL WORCESTER INDUSTRIAL CERAMICS, LTD.
Ceramic thermocouple insulators.
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Thermocouples.
SPEMBLY, LTD.
Precision, multi-junction, thermal analysis.
TECHNOGRAPH ELECTRONIC PRODUCTS, LTD.
VACUUM INDUSTRIAL APPLICATIONS, LTD.

444 THORIUM

BORAX AND CHEMICALS, LTD.
Compounds and high purity oxide.
NEW METALS AND CHEMICALS, LTD.
Metal all forms, oxide.
THORIUM, LTD.
Reactor grade oxide, thorium salts.

445 TUBES, EXTENDED SURFACE

T.I. NUCLEAR ENGINEERING, LTD.
Mild, alloy, s.s., aluminium, magnesium.
ACCLES AND POLLOCK, LTD.
ADAMSON, DANIEL, AND CO., LTD.
Longitudinally finned.
BIRMINGHAM BATTERY AND METAL CO., LTD., THE.
Baffairfin finned tubing in copper and alloys.

445 TUBES, EXTENDED SURFACE (contd.)

BIRWELCO, LTD.
CLARKE, CHAPMAN AND CO., LTD.
Fin welding.
CLAYTON DEWANDRE CO., LTD.
CRITTALL-LUXFER, LTD.
Finned. Non-ferrous low tolerance.
FAIREY CO., LTD., THE.
HOWELL AND CO., LTD.
LUCAS, JOSEPH, LTD.
Ferrous.
RICHARDS AND ROSS, LTD.
SIMON-CARVES, LTD.
SPIRO-GILLS, LTD.
STANDARD AND POCHIN BROS., LTD.
Gilled coffer tube.
THERMO ENGINEERS, LTD.
Spiral wound gilled tubes.
TOMLINSONS (ROCHDALE), LTD.
"Turbiex" gilled.
TUBE PRODUCTS, LTD.
Welded helical fin.
TUBES, LTD.
UNITED AIR COIL, LTD.

446 TUBES, FLEXIBLE

ABBOFLEX, LTD.
ACCLES AND POLLOCK, LTD.
APPLEBY AND IRELAND, LTD.
Tubes, flexible—Metallic and p.t.f.e., etc.
AVICA EQUIPMENT, LTD.
Stainless steel or synthetic rubber.
BOWDEN (ENGINEERS), LTD.
Wire braided rubber, plastic and metallic hose.
BRITISH INSULATED CALLENDER'S CABLES, LTD.
Cabled nylon tube.
COMPOFLEX CO., LTD.
High temperature, pressure, liquid gas hoses.
DUNLOP RUBBER CO., LTD.
High and low pressure.
ENGINEERING APPLIANCES, LTD.
EXTRUDEX, LTD.
JOHNSON AND PHILLIPS, LTD.
"Junotube," cabled, nylon, copper.
LABORATORY APPARATUS AND GLASS BLOWING CO.
Rubber, plastic.
OIL FEED ENGINEERING CO., LTD.
Hi-flex p.t.f.e. and all types of synthetic rubber.
PLASTICABLE, LTD.
P.v.c. sheathed metallic.
PLESSEY CO., LTD.
Plessiflex seamless flexible metallic hose.
POWER AUXILIARIES, LTD.
POWER FLEXIBLE TUBING CO., LTD., THE.
Metallic.
RESISTANT EQUIPMENT, LTD.
Plasticised p.v.c.
SANDERS, W. H. (ELECTRONICS), LTD.
SMITHS (Industrial Instrument Division)
Petroflex.
TECALEMIT, LTD.
Titeflex metal, nylon.
UNITED FLEXIBLE METALLIC TUBING CO., LTD., THE.

447 TUBING

Q.V.F., LTD.
ACCLES AND POLLOCK, LTD.
ALMIN, LTD.
Aluminium.
APPLEBY AND IRELAND, LTD.
Tubing s.s., p.t.f.e., etc.
BIRKETT, T. M., BILLINGTON AND NEWTON, LTD.
Chill cast and continuous cast. Rods.
BIRMINGHAM BATTERY AND METAL CO., LTD., THE.
Copper and copper alloys for heat exchangers.
BRITISH INSULATED CALLENDER'S CABLES, LTD.
Cabled copper tube for instrumentation.
BROWN, JOHN (S.E.N.D.), LTD.
Manipulation.
CHESTERFIELD TUBE CO., LTD., THE.
Seamless carbon, alloy, s.s., Be, Ti, Zr.
COLLIER AND COLLIER, LTD.
Worm drive hose clips.
CRITTALL-LUXFER, LTD.
Thin wall, aluminium and magnesium alloys.
ENGELHARD INDUSTRIES, LTD.
Precious metal.
HELLERMANN, LTD.
Moulded and extruded plastics, cable binding and identification system.
HOWELL AND CO., LTD.
Seamless, carbon, low alloy steels.
HOYT METAL CO. OF GREAT BRITAIN, LTD., THE.
Bronze tubing and rods, extruded and cold drawn.
INDUSTRIAL SPECIALTY (IRON AND STEEL), LTD.
Steel.
INSULATING COMPONENTS AND MATERIALS, LTD.
KAYE, E. AND E., LTD.
Tubing.
KIRK AND CO. (TUBES), LTD.
LABORATORY APPARATUS AND GLASS BLOWING CO.
Glass, nylon, rigid p.v.c.
LAMSON ENGINEERING CO., LTD.
Isotope carrying airtubes.
MACNAYS, LTD.
Tubes to BS 1387; 806 A and B; A.P.I. W.I. fittings and flanges.
MAITLANDS (METAL WORKS), LTD.
MENDIP (CHEMICAL ENGINEERING), LTD.
Tubing in reinforced resin.
MOFFAT ENGINEERING CO., LTD.
NEW METALS AND CHEMICALS, LTD.
Tantalum, beryllium, molybdenum, thorium, titanium, zirconium.
OSBORN, SAMUEL, AND CO., LTD.
PLASTICABLE, LTD.
P.v.c. sheathed copper.
PRESS, WILLIAM, AND SON, LTD.
REDPATH BROWN AND CO., LTD.
RESISTING EQUIPMENT, LTD.
Polythene, rigid p.v.c., plasticised p.v.c.
REYNOLDS TUBE CO., LTD.
Cold drawn seamless steel.
RICHARDS AND ROSS, LTD.
ROLLO-HARDY AND CO., LTD.
Stainless steel and mild steel tubing.
SERCK TUBES, LTD.
Condenser, heat exchanger.
SHEEPBRIDGE ALLOY CASTINGS, LTD.
Radiant heat, bi-metal, long centrifugally cast.
STEWARTS AND LLOYDS, LTD.
TALBOT STEAD TUBE CO., LTD.
Carbon, alloy steel, s.s.; clad, graphite.
TUBES, LTD.
Seamless steel to 8½ in. o.d.
UNITED AIR COIL, LTD.
VICSONS, LTD.
Polythene, p.v.c. and rubber.
WELDLESS STEEL TUBE CO., LTD.
Hot finished seamless, carbon, alloy steels.
YORKSHIRE IMPERIAL METALS, LTD.

448 URANIUM

ALBRIGHT AND WILSON (MFG.), LTD.
Tributyl phosphate.
FAIREY CO., LTD., THE.
Machining.
NEW METALS AND CHEMICALS, LTD.
PERMUTIT CO., LTD., THE.
Ion exchange plant.
RIO TINTO MANAGEMENT SERVICES (U.K.), LTD.
Mill grade precipitate, nuclear grade salts, ceramic grade UO_2; metal machined ingot; fabricated fuel materials.
UNITED KINGDOM ATOMIC ENERGY AUTHORITY.

449 VALVES

A.P.V. CO., LTD., THE.
S.s.
B.E.N. PATENTS, LTD.
Non-return, pressure reducing, relief, safety.
I.V. PRESSURE CONTROLLERS, LTD.
K.S.B. MANUFACTURING CO., LTD.
Glandless, normal.
N.G.N. ELECTRICAL, LTD.
Magnetic to 4-in. bore, hand, baffle.
N.V. TOOLS, LTD.
S.s., high, low pressure, relief.
Q.V.F., LTD.
SPE CO., LTD.
Non-return, level control.
ALLEY AND MACLELLAN, LTD.
APPLEBY AND IRELAND LTD.
Valves—gate and bellows sealed (s.s., monel, etc.).
APPLETON AND HOWARD, LTD.
For chemical corrosive liquids.
AUDLEY ENGINEERING CO., LTD.
Audco lubricated taper plug, annin control.
BAILEY, SIR W. H., AND CO., LTD.
Sluice.
BELL PRECISION ENGINEERING CO., LTD.
BENTON AND STONE, LTD.
BIRFIELD INDUSTRIES, LTD.
Air and fluid control.
BIRKETT, T. M., BILLINGTON AND NEWTON, LTD.
Fittings.
BLACK AUTOMATIC CONTROLS, LTD.
BLAKEBOROUGH, J., AND SONS, LTD.
BLOCTUBE CONTROLS, LTD.
BOLTON (THOMAS) AND SONS, LTD.
Machined parts.
BOVING AND CO., LTD.
BRADSHAW AND CO. (ACCRINGTON), LTD.
Motorized, standard and specials.
BRITISH ARCA REGULATORS, LTD.
Diaphragm-operated control.
BRITISH ERMETO CORPORATION, LTD.
Valves, H.P. shut off, control, non-return instrument and gate.
BRITISH STEAM SPECIALTIES, LTD.
CHAMBERLAIN INDUSTRIES, LTD.
Hydraulic.
COCKBURNS, LTD.
Fluid, gas, vapour; cast, fabricated.
CORTIN AND CORKING, LTD.
Acid (regulus metal).
CROSBY VALVE AND ENGINEERING CO., LTD.
Safety, relief, diaphragm operated.
DE HAVILLAND ENGINE CO., LTD., THE.
Small for radioactive circuits.
DEWRANCE AND CO., LTD.
DONKIN, BRYAN AND CO., LTD., THE.
High-pressure gas.
EDWARDS HIGH VACUUM, LTD.
Vacuum; protective devices.
ELECTRO-HYDRAULICS, LTD.
ELLIOTT NUCLEONICS, LTD.
Control.
ETHER, LTD.
Magnetic, solenoid.
FARNELL INSTRUMENTS, LTD.
FARRER, WILLIAM E., LTD.
Steel, c.i.; sluice gates, penstocks.
FARRIS ENGINEERING, LTD.
Safety, relief; steel, s.s., bronze; rubber pinch.
FIRKINS, G. AND A., LTD.
FISHER GOVERNOR CO., LTD.
Automatic control and dump.
FLEISCHMANN (LONDON), LTD.
High vacuum.
FLEXIBOX, LTD.
Valves, stop.
FLIGHT REFUELLING, LTD.
Hand and electrically operated hot gas valves.
GENEVAC, LTD.
GLENFIELD AND KENNEDY, LTD.
Sluices, consultation design.
GOODWIN, ARNOLD, LTD.
GORDON, JAMES, VALVES, LTD.
Main CO_2 isolating and by-pass valves.
HAM, BAKER AND CO., LTD.
Sluice, non-return, flap, penstocks.
HAMWORTHY ENGINEERING, LTD.
HIGH PRESSURE COMPONENTS, LTD.
HOPKINSONS, LTD.
Valves, pipe valves, turbine valves, boiler mountings, butterfly valves.
HUNT AND MITTON, LTD.
Control, diaphragm, cylinder, or electric motor operation.
HYDRAULICS AND PNEUMATICS, LTD.
Hydr. and pneu., selector, unloader, relief.
INNESS AND CO. (DARLINGTON), LTD.
Special purpose, belows seal, motorised.
INTEGRAL, LTD.
JONES AND STEVENS, LTD.
Solenoid, pressure, vacuum, taps.
KLINGER, RICHARD, LTD.
Automatic, cocks.
LANG PNEUMATIC, LTD.
Solenoid.
LANGDALE ENGINEERING CO., LTD.
Regulating, solenoid sequence, hydraulic; all types for manual and automatic control.
LANGLEY ALLOYS, LTD.
S.s., nickel alloys.
LAYCOCK ENGINEERING, LTD.
Birflo control valves and filters for gases and fluids.
LIMITORQUE VALVE CONTROLS, LTD.
Valve actuators, electric pneumatic, hydraulic, gas- and air-operated.
LONGCLOSE ENGINEERING CO., LTD., THE.
Fullway.
LUCAS, JOSEPH, LTD.
Hydraulic, magnetic, pneumatic, reducing.
MACDONALD, J., AND CO. (PNEUMATIC TOOLS), LTD.
Pressure-seated air.
McKELLEN, S. D., LTD.
MADAN, CHARLES S., AND CO., LTD.
High-pressure hydraulic.
MAGNETIC VALVE CO., LTD.
MARTONAIR, LTD.
Control, pneumatic, hydraulic.
MEAKES, J. G., LTD.
Manufacture of special vacuum valves.
MERRILL PUMPS, LTD.
Pressure relief, straight-way, multiport.
METRO-FLEX ATOMIC ENGINEERING, LTD.
Isolating duct.
MEYNELL AND SONS, LTD.
Gunmetal, steam, air, gas, acid, fittings, specials.
MIDLAND INDUSTRIES, LTD.
Pressure reducing, H.P.H. water, stop, check.
MILLSPAUGH, LTD.
MOFFAT ENGINEERING CO., LTD.
MOORE'S (WALLISDOWN), LTD.
High pressure, s.s.
MUNTZ, ALAN AND CO., LTD.
Automatic air.
NETTLEFOLD AND MOSER, LTD.
NEWMAN, HENDER AND CO., LTD.
NORGREN, C. A., LTD.
Compressed air, liquid pressure, regulator reducing.
NUMATION VALVES, LTD.
OPPERMAN GEARS, LTD.
Speed reducers, spur, worm, bevel, helical gearcutting.

449 VALVES (contd.)

OWEN ORGANISATION, THE.
Electrically operated (hydraulic, electro-hydraulic and pneumatic).
PALATINE (SURBITON), LTD.
PALMER AERO PRODUCTS, LTD.
PULVERIZING MACHINERY, LTD.
RESISTANT EQUIPMENT, LTD.
Polythene and p.v.c.
RHODES, B., AND SON, LTD.
Cocks, pure nickel, s.s., monel.
RICHMOND INSTRUMENT CO., LTD.
ROTHERHAM AND SONS, LTD.
ROTORK, LTD.
Valve actuators.
RYDER, THOS., AND CO. (MANCHESTER), LTD.
Cocks, s.s., g.m., c.i., aluminium.
SALFORD ELECTRICAL INSTRUMENT, LTD.
Rotary gas sampling valves.
SAMSON CONTROLS (LONDON), LTD.
Diaphragm and self-operated. (A)
SANDFORD, THOMAS (ROCHDALE), LTD.
SAUNDERS VALVE CO., LTD.
Diaphragm.
SAUTER CONTROLS, LTD.
Electric, pneumatic and solenoid.
SAVERY, THOMAS, PUMPS LTD.,
Hydraulic.
SCOTTS ENGINEERING (NEWPORT), LTD.
Scotomic stainless steel valves and Pearson-Scott diaphragm valves.
SIMMONDS AEROCESSORIES, LTD.
Liquid.
SMITH, SYDNEY, AND SONS (NOTTINGHAM), LTD.
High pressure, cocks.
SPEMBLY, LTD.
Low pressure relief.
SPRINGHAM, G., AND CO.
TALBOT STEAD TUBE CO., LTD.
Cupford diaphragm.
TEDDINGTON INDUSTRIAL EQUIPMENT, LTD.
Solenoid, motorized, thermostatic pressure-operated.
TELEKTRON (GREAT BRITAIN), LTD.
TERRASPAN, LTD.
TOWLER BROS. (PATENTS), LTD.
Oil, hydraulic, control.
TRESS ENGINEERING CO., LTD., THE.
High pressure drop forged.
UNITED STATES METALLIC PACKING CO., LTD.
Auto grind.
URQUHARTS (1926), LTD.
Multi-port, control.
VACUUM INDUSTRIAL APPLICATIONS, LTD.
VACUUM METALLURGICAL DEVELOPMENTS, LTD.
Vacuum pressure; 1 in. to 48 in.
VACUUM RESEARCH (CAMBRIDGE), LTD.
High vacuum; automatic, hand 2 in. to 30 in., specials.
VICKERS-ARMSTRONGS (ENGINEERS), LTD.
WALKER, C. AND W., LTD.
Solenoid; gas.
WARREN, MORISON, LTD.
Rubber diaphragm, rubber pinch.
WESTERN DETAIL MANUFACTURERS, LTD.
WILKINSON RUBBER LINATEX, LTD.
WILLIAMS AND JAMES (ENGINEERS), LTD.
Reducing, bronze, s.s.

450 WATER TREATMENT

AITON AND CO., LTD. (DERBY).
Distillation plant.
ALBRIGHT AND WILSON (MFG.), LTD.
Phosphates for water conditioning.
BENNIS COMBUSTION, LTD.
Flash type distillation plant.
BOBY, WILLIAM, AND CO., LTD.
BRACKETT, F. W., AND CO., LTD.
Self-cleaning screens, strainers.
CANDY FILTER CO., LTD., THE.
FARRER, WILLIAM E., LTD.
Screens, sludge removal, sewage purification.
GLENFIELD AND KENNEDY, LTD.
Micro fine and coarse rotary-strainers.
HEAD WRIGHTSON PROCESSES, LTD.
HICK HARGREAVES AND CO., LTD.
Self-cleaning strainers, de-aerators.
HOUSEMAN AND THOMPSON, LTD.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
"Alfloc" water treatment service.
LANCASTER AND TONGE, LTD.
Strainers, single, duplex to 24 in. bore.
LEDWARD AND BECKETT, LTD.
Circulating water screens, strainer boxers, water jet condensers.
LENNIG, CHARLES, LTD.
MENDIP (CHEMICAL ENGINEERING), LTD.
Tanks and piping.
PERMUTIT CO., LTD., THE.
PULSOMETER ENGINEERING CO., LTD., THE.
Water treatment plant.
PYE, W. G., AND CO., LTD.
SIMON-CARVES, LTD.
Purification plant.
STEEL, J. M., AND CO., LTD.
SUTCLIFFE, SPEAKMAN AND CO., LTD.
THOMPSON, JOHN, LTD.
THOMPSON-KENNICOTT, JOHN, LTD.
Softeners, de-aerators.
WALLACE AND TIERNAN, LTD.
WESTWOOD, JOSEPH, AND CO., LTD.
Screens.
WHIFFEN AND SONS, LTD.
Zerox hydrazine, Metaquest, Ralsin (A).

451 WELDING

A.C.M. ELECTRONICS, LTD.
Welding.
A.I. ELECTRIC WELDING MACHINES, LTD.
Automatic flash butt.
C. AND N. (ELECTRICAL), LTD.
ALUMINIUM WIRE AND CABLE CO., LTD.
ARC MANUFACTURING CO., LTD.
Electrodes, transformers, welding accessories.
BADDELEY, D. S., ENGINEERING CO., LTD.
BATES BROS. (ENGINEERS), LTD.
BRITISH INDUSTRIAL GASES, LTD.
Heating equipment; suppliers of all accessories.
BRITISH INSULATED CALLENDER'S CABLES, LTD.
BRITISH OXYGEN GASES, LTD.
Gas welding and cutting.
BROWN, E. G., AND CO., LTD.
Argon arc, electric spot and seam welding.
BROWN, JOHN (S.E.N.D.), LTD.
Electrodes, equipment.
BURNLEY AIRCRAFT PRODUCTS, LTD.
Machines; special purpose equipment, electrodes.
CENTRAJET, LTD.
Hi-Lo Universal oxygen hand cutter; nozzles.
CLARKE, CHAPMAN AND CO., LTD.
Class 1.
COOPER AND TURNER, LTD.
Diadem arc welding electrodes, plant and equipment.
COURTBURN POSITIONERS, LTD.
Positioners, rotators, platens, electrode holders and welding accessories.
COX AND DANKS, LTD.
DELORO STELLITE, LTD.
Stellite hardfacing rods.
ELECTRO MECHAN-HEAT, LTD.
Spot, seam, projection, flash welders.
ELECTROTHERMAL ENGINEERING, LTD.
Heaters, stress relieving.
ENGLISH ELECTRIC CO., LTD., THE.
ESAB, LTD.
Electrodes, generators, extractor fans, cutting machines.
EUTECTIC WELDING ALLOYS CO., LTD.
Sole manufacturers and patentees of Eutectic Low Temperature Welding Alloys, electrodes and fluxes.
FAIRLEEDE ENGINEERING, LTD.
Electric manual and automatic argon arc.
FARMER BROS. (SHIFNAL), LTD.
FARR, EDWARD, LTD.
Automatic fusarc.
GENERAL ELECTRIC CO., LTD., THE.
Transformer welding equipment and accessories.
HALL ENGINEERING, LTD.
HAWKER SIDDELEY NUCLEAR POWER CO., LTD.
Stainless, alum and m. steel—to very high standards.
HEAD WRIGHTSON TEESDALE, LTD.
IBBETT ENGINEERING CO., LTD.
Positioners.
INVICTA ELECTRODES, LTD.
JOHNSON, MATTHEY AND CO., LTD.
Electrodes (resistance).
LINCOLN ELECTRIC CO., LTD.
Automatic, semi-automatic submerged arc, electrodes, accessories.
MAITLANDS (METAL WORKS), LTD.
MEAKES, J. G., LTD,
Welding of stainless steel vessels to high vacuum standards.
MERITUS (BARNET), LTD.
Resistance welding machines.
METRO-CUTANIT, LTD.
Welding—resistance welding electrodes.
MINNESOTA MINING AND MANUFACTURING CO., LTD.
"Scotch" brand glass cloth tape.
MOORE, W. AND E., LTD.
Profile-cutting.
MOTHERWELL BRIDGE AND ENGINEERING CO., LTD., THE.
MUNRO AND MILLER, LTD.
Tubecraft welding fittings in all alloys.
MUREX WELDING PROCESSES, LTD.
NELSON ENGINEERING CO., LTD., THE.
NEWBURGH ENGINEERING CO., LTD.
OWEN ORGANISATION, THE.
All types. Including the new Rowen-arc process. Welding rods.
PETBOW, LTD.
Arc, plant and accessories.
PETERS, G. D., AND CO., LTD.
PHILLIPS ELECTRICAL, LTD.
PIPEWORK AND ENGINEERING (BRISTOL), LTD.
PRESS, WILLIAM, AND SON, LTD.
QUASI-ARC, LTD.
RADIO HEATERS, LTD.
Plastics.
REDIFON, LTD.
R.F. plastic welders.
RESEARCH AND CONTROL INSTRUMENTS, LTD.
Electrodes, arc, plant, CO_2 equipment.
ROCKWELD, LTD.
ROSS, DONALD, AND PARTNERS, LTD.
Jigs, positioners, manipulators, rotators, pipe tools.
SATURN INDUSTRIAL GASES, LTD.
Saturn-Hivolt surge injector argon arc.
SPEEDY AND EYNON (1951), LTD.
Argon arc.
SPEMBLY, LTD.
Equipment for fine wire and foils.
SUFFOLK IRON FOUNDRY (1920), LTD.
Oxy-acetylene welding rods, fluxes and equipment.
TOWLER AND SON, LTD.
VICKERS-ARMSTRONGS (AIRCRAFT), LTD.
WATTS METAL INDUSTRIES, LTD.
Electric and gas, not on site.
WELDCRAFT, LTD.
Electrodes, accessories, gas, arc and cutting.
WELDCRAFT, LTD.
Arc and gas welding equipment, electrodes, rods
WELDING SUPPLIES, LTD.
WESTERN DETAIL MANUFACTURERS, LTD.
YATES PLANT, LTD.
Manipulative equipment.
YOUNG, A. S., AND CO., LTD.
Rods, electrodes, fluxes, accessories, arc.

452 WIRE; Wirework

A.C.M. ELECTRONICS, LTD.
Machinery guards, baskets, etc.
G.K.N. REINFORCEMENTS, LTD.
ALUMINIUM WIRE AND CABLE CO., LTD.
BARNS, W., AND SON (HOLLOWAY), LTD.
Perforated metals, cable trays.
CARTER, B. AND F., AND CO., LTD.
Braiding, cable, rope machinery.
CONNOLLYS (BLACKLEY), LTD.
Insulated single; stranded, strip.
ENDECOTTS (FILTERS), LTD.
Wire gauge filter elements.
HARVEY, G. A., AND CO. (LONDON), LTD.
INDUSTRIAL SPECIALTY (IRON AND STEEL), LTD.
JOHNSON, RICHARD, AND NEPHEW, LTD.
KAYE, E. AND E., LTD.
Wire.
KNITMESH, LTD.
Knitted mesh.
LEE, ARTHUR, AND SONS, LTD.
Mild, carbon and stainless.
LONDON ELECTRIC WIRE CO. AND SMITHS, LTD.
POTTER, F. W., AND SOAR, LTD.
Wire gauze, woven wire.
SHAW, JOHN, LTD.
Ropes, special steel.
SMITH, FREDERICK, AND CO.
All gauges, copper sections, strips.
TALBOT STEAD TUBE CO., LTD.
Bright drawn.
WEST LONDON IRON AND WIRE WORKS, LTD.
Wire, wirework, machinery guards, dipping baskets, etc.

453 ZIRCONIUM

T.I. NUCLEAR ENGINEERING, LTD.
Fuel element sheaths, supports, pressure tubes.
ACCLES AND POLLOCK, LTD.
BROWN, JOHN (S.E.N.D.), LTD.
CHESTERFIELD TUBE CO., LTD., THE.
Elemental; alloys.
IMPERIAL CHEMICAL INDUSTRIES, LTD.
JESSOP-SAVILLE, LTD.
LIGHT-METAL FORGINGS, LTD.
Forgings.
NEW METALS AND CHEMICALS, LTD.
PODMORE, W., AND SONS, LTD.
Silicate flour.
SAVILLE, J. J., AND CO., LTD.
ITANIUM METAL AND ALLOYS, LTD.
Bar, sheet, forgings.